Geotechnical Research Centre

WESTERN UNIVERSITY, CANADA

Leading the field of geotechnical and geoenvironmental engineering

Western
Geotechnical
Research Centre

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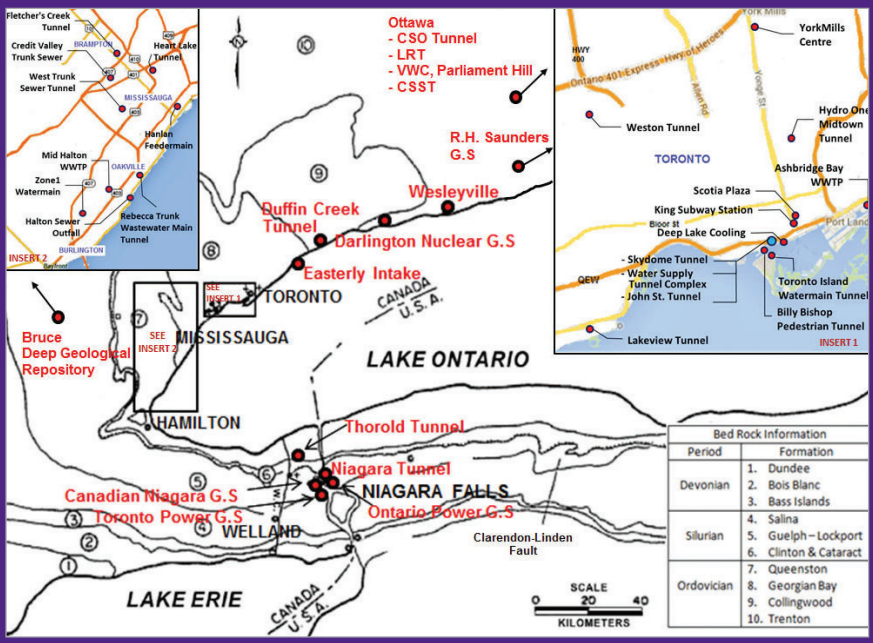
The Geotechnical Research Centre

Dr. Kwan Yee Lo

One of the founding members of the GRC, Dr. Kwan Yee Lo is the managing director of the centre. He is internationally recognized for soft clay engineering, slope stability, tunnelling in soft ground tunnels and foundations in rock, and concrete dams on rock foundations. In 1997, the Engineering Institute of Canada honoured Dr. Lo's contributions to engineering by establishing the K.Y. Lo Medal, which is awarded annually to an outstanding Canadian Engineer who has made significant contributions around the world.

Map showing location of projects that utilized GRC methodology for testing and design of underground projects in Southwestern Ontario



Bed Rock Information	
Period	Formation
Devonian	1. Dundee 2. Bois Blanc 3. Bass Islands
Silurian	4. Salina 5. Guelph – Lockport 6. Clinton & Cataract
Ordovician	7. Queenston 8. Georgian Bay 9. Collingwood 10. Trenton

A. R.H.Saunders G.S.
St. Lawrence River

B. Otto Holden G.S.
Ottawa River

C. Caribou Falls G.S.
English River

History

In 1965, L.G. Soderman formed one of the first Soil Mechanics Sections in Canada at Western University. The Geotechnical Research Centre (GRC) emerged from this pioneering group in 1984.

The founding members of the GRC include: K.Y. Lo, M.N. Novak, R.M. Quigley and R.K. Rowe. This group envisioned a dynamic multidisciplinary collection of engineering researchers, scientists and engineers capable of interfacing with industry to solve problems of practical importance for both industry and government.

Today, the GRC has outstanding state-of-the-art research facilities, dedicated technical and administrative staff, and nine active core faculty members whose expertise spans a broad spectrum of geotechnical and geoenvironmental engineering. In addition to grant supported research, graduate student training, short courses for professional engineers and research publications, the GRC also offers highly specialized contract research and services in the following areas:

- Stability of soil and rock slopes
- Soft ground tunnelling
- Deep excavations and tunnels in rock
- Contaminant transport through soil and fractured rock
- Soil dynamics and small strain behaviour
- Static and dynamic soil-structure interaction analysis
- Stability analysis of concrete and earth fill dams
- Soil remediation and site restoration
- Groundwater and geochemical modelling
- Groundwater and surface water interactions
- High quality advanced stress path laboratory testing
- Measurement of design parameters in swelling rock

The primary mission of the GRC is to conduct geotechnical, geoenvironmental and multidisciplinary research with emphasis on interfacing with industry. The GRC also contributes to the global competitiveness of Canadian industry by training highly skilled Masters and PhD students while working on relevant projects. In addition, by interfacing with industry, the GRC maximizes the impact of research undertaken by its core members and associates. Some of the testing and design methodology developed by GRC are widely used in the industry.

Key Research Areas

With nine research directors and 10 associate members, the GRC can form small or large multidisciplinary research teams capable of solving complex problems faced by industry and government. In addition, GRC directors have provided specialized services in numerous engineering projects to consulting companies with complex numerical analyses, high level training or specialized laboratory testing, and innovative design measures leading to the resolution of challenging engineering issues.

The GRC's research and consulting capabilities fall under the following main areas:

CIVIL INFRASTRUCTURE

- Soft ground and rock tunnelling
- Highway and railway embankments on soft soil
- Retaining walls, shoring systems, and soil anchors
- Deep excavations in soil and rock
- Underground infrastructure such as tunnels, sewers and water mains, culverts and subway stations
- Innovative deep and shallow foundations for static and seismic loads

ENERGY AND NATURAL RESOURCES

- Nuclear site evaluation, powerhouse foundations, intake and discharge structures and seismic studies
- Concrete dams on rock foundations and embankment dams
- Machine foundations, and base or vibration isolation systems
- Offshore engineering - reclamation of dredged sediments, cargo offloading platforms, offshore foundations, and temporary anchor systems for underwater construction
- Foundations for renewable energy technology
- Mine waste management and characterisation
- Sustainability of geotechnical resources

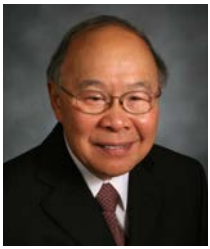
ENVIRONMENT

- Nuclear waste repositories — evaluation of host rock and design
- Removal of pharmaceutical and endocrine-disrupting compounds from drinking water
- Efficiency of nanoadsorbents in the removal of arsenic and chromium from wastewater and groundwater
- Soil cover systems for mine waste and municipal solid waste
- Electrokinetic consolidation of low level mine tailings
- Performance of covers over reactive mine tailings and waste rock

CONTAMINANT HYDROGEOLOGY AND SITE REMEDIATION

- Engineered nanoparticles for groundwater remediation
- STAR remediation for coal tar and hydrocarbon contaminated soils
- Experiment and advanced computer modelling for remediation system design (www.eng.uwo.ca/research/restore)
- Innovative remediation technologies for contaminated soil and groundwater

Research Directors



KWAN YEE (K.Y.) LO, PhD, P.Eng., FEIC
Managing Director, Professor Emeritus
www.eng.uwo.ca/people/klo

Energy and Resources Development

- Underground structures in rock
- Deep excavations in soils and rock
- Slope stability in difficult soil conditions

M. HESHAM EL NAGGAR, PhD, P.ENG., FEIC
Associate Dean, Research and Graduate Studies
www.eng.uwo.ca/people/helnaggar

Civil Infrastructure

- Design of machine foundations
- Static and dynamic analysis of piles
- Soil dynamics and geotechnical earthquake engineering

JASON GERHARD, PhD, P.Eng.
Associate Professor
www.eng.uwo.ca/research/restore/gerhard.html

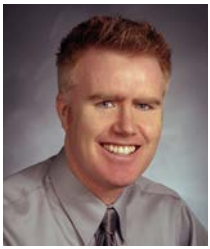
Contaminant Hydrogeology and Site Remediation

- Innovative techniques for remediation of soil and groundwater
- Geophysics for mapping contaminated sites
- Numerical modeling of pollutants in the subsurface

TIM NEWSON, PhD
Associate Professor
www.eng.uwo.ca/people/tnewson

Civil Infrastructure

- Cyclic and static laboratory stress-strain testing and constitutive modelling
- Finite element and small scale physical modelling of complex boundary value problems
- Geotechnics for offshore infrastructure and wind farms



DENIS O'CARROLL, PhD, P.Eng.
Associate Professor
www.eng.uwo.ca/research/restore/ocarroll.html

Contaminant Hydrogeology and Site Remediation

- Fate of nanoparticles in the environment
- Performance of green roofs
- Development of innovative remediation technologies

CLARE ROBINSON, PhD
Associate Professor
www.eng.uwo.ca/research/restore/robinson.html

Contaminant Hydrogeology and Site Remediation

- Groundwater and geochemical modeling
- Groundwater-surface water interactions

Research Directors continued

ABOUZAR SADREKARIMI, PhD, P.Eng.
Assistant Professor
www.eng.uwo.ca/people/asadrek

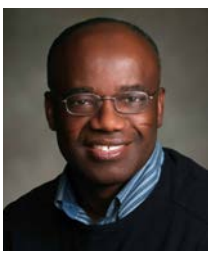
Geotechnical

- Soil dynamics and geotechnical earthquake engineering
- Static and cyclic behavior of soils
- Advanced laboratory and field soil testing
- Geotechnical physical model testing

JULIE Q. SHANG, PhD, P.Eng.
Professor
www.eng.uwo.ca/people/jshang

Environmental

- Electrokinetics for geotechnical and environmental engineering applications
- Management of reactive mine tailings: prevention and mitigation
- Using electromagnetic waves for detection of subsurface contamination



ERNEST YANFUL, PhD, P.Eng.
Professor
www.eng.uwo.ca/people/eyanful

Environmental

- Mine water treatment using sustainable novel absorbents
- Acid rock drainage
- Advanced oxidation methods for water and wastewater treatment
- Landfill design and performance in tropical environments

Associate Members

F.M. BARTLETT, PhD, P.Eng.
Associate Dean (Academic)
Professor, Civil and Environmental Engineering
Western University

A. EL DAMATTY, PhD, P.Eng.
Professor and Department Chair, Civil and Environmental Engineering
Western University

S. HINCHBERGER, PhD, P.Eng.
Adjunct Professor, Civil and Environmental Engineering
Western University
Associate and Geotechnical Lead, Hatch Associates Ltd.

H.P. HONG, PhD, P.Eng.
Professor, Civil and Environmental Engineering
Western University

S. MICIC, PhD, P.Eng.
Adjunct Professor, Civil and Environmental Engineering
Western University
Senior Geotechnical Engineer, EXP Services Inc.

I.D. MOORE, PhD, P.Eng.
Adjunct Professor, Civil and Environmental Engineering
Canada Research Chair in Infrastructure Engineering
Queen's University

G. NAKHLA, PhD, P.Eng.
Professor, Civil and Environmental Engineering
Salamander Chair
Western University

M. L. NEHDI, PhD, P.Eng.
Professor, Civil and Environmental Engineering
Western University

R.K. ROWE, PhD, DEng, P.Eng., FREng, FRSC, FCAE, FEIC, FASCE, FIE (Aust), P.Eng.
Adjunct Professor, Civil and Environmental Engineering
Professor and Canada Research Chair - Tier I
Queen's University

C. YUEN, PhD, P.Eng.
Adjunct Professor, Civil and Environmental Engineering
Western University
Senior Consultant, Golder Associates Limited

Geotechnical Services

GRC researchers are involved in many projects, both as consultants and as researchers. The expertise of this group has enabled geotechnical research to cross traditional disciplines and foster extensive collaborations between the University and industry, resulting in the resolution of many issues in various projects worldwide.

- Strength testing of dam foundation interface
- Swell tests on shaly rocks
- Specialized rock and soil testing
- Static and dynamic soil-structure interaction analysis (residential and industrial foundations, shoring, retaining walls, tunnels in soil or rock)
- Analytical testing of soil and groundwater
- Seismic ground response analysis
- Site characterization and remediation design
- Mine waste disposal and decommissioning strategies
- Professional training and advanced short courses
- Expert review

Computer Software

DYNA6.1 Software

The DYNA6.1 program returns the response of rigid foundations to all types of dynamic loads. The rotation of centrifugal or reciprocating machines, shock-producing machines, earthquakes, traffic and other sources of dynamic forces can produce these loads. The foundation can be supporting a single or multiple machines. The response to harmonic loading for a flexible, rectangular mat on elastic half-space or on a group of piles can also be calculated. The stiffness and damping constants of the foundation (needed for the analysis) are evaluated within the program for surface foundations, embedded foundations and piles, pile interaction in a group and other features. For rigid footings, all six degrees of freedom are considered as coupled.

The foundation stiffness and damping constants (matrices) are also returned for possible use in soil-structure interaction analysis. These constants are available for rigid footings, flexible mats (caps) on piles, or piles without any connecting cap, and also for flexible mats on elastic half-space.

DYNA6.1 can calculate the frequency dependant stiffness and damping constant of both shallow and pile foundations to different types of dynamic loads. The main engine of DYNA6.1 is double precision for more accuracy and more stability of numerical processing, especially when you have soil layers with stark difference in shear wave velocity values and/or thickness.

DYNA6.1 is 32 bit and 64 bit and is compatible with Windows 7.

Significantly enhanced pre- and post-processors. They make data input and getting the results much more efficient and compatible with Excel. In addition, the program now allows for automatic storage of files in subdirectories according to the name of the file run and different cases.

For inquiries, please e-mail: **cquintus@uwo.ca**

www.eng.uwo.ca/grc/dyna6

Specialized Test Equipment

The GRC operates several modern research laboratories. In addition to the standard geotechnical and geoenvironmental laboratory equipment, the following specialized equipment are available for projects.

ADVANCED CONCRETE TECHNOLOGY

- Malvern laser diffraction particle size analyzer
- Freeze thaw cabinet
- Micromeretics nitrogen adsorption surface area analyzer

ELECTROKINETICS

- Electrokinetic model tank for strengthening and consolidation
- Electrokinetic cells
- Equipment for measurement of electrical conductivity And permittivity of soils

ENVIRONMENTAL GEOCHEMISTRY

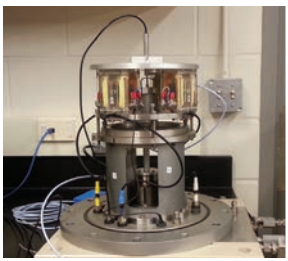
- Mercury intrusion porosimeter
- Gas chromatograph with mass spectrometer
- High performance liquid ion chromatograph
- Zeta potential and dynamic light scattering particle analyzer
- X-ray diffraction
- Pore water squeeze
- Inductive-coupled plasma optical emission spectrometer (ICP-OES)
- X-ray fluorescence (Earth Sciences)
- Scanning electron microscopy
- Spectrophotometer
- Pressure plate extractors (1-100 Bar)
- Diffusion cells for monitoring oxygen diffusion through unsaturated soils

STRUCTURES

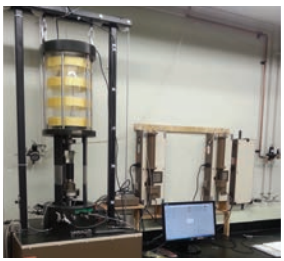
- Various compression and extension loading machines up to 1780kN compression and 960kN tension

GEOTECHNICAL

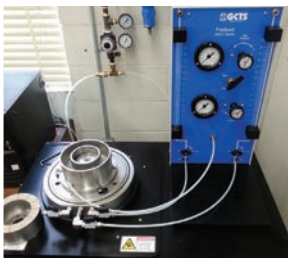
- Computer controlled fixed wall and flexible wall hydraulic conductivity
- Soil calibration chamber for controlled CPT and pile testing
- Experimental soil testing site for full-scale pile testing
- Computer controlled triaxial stress path systems (monotonic and cyclic)
- Resonant column device for measuring dynamic soil properties
- GDS cyclic triaxial device for measuring strength and stiffness of soils under cyclic loading conditions (i.e. seismic and wind loading applications
- Advance cyclic ring shear testing apparatus capable of testing unsaturated soils and measuring shear wave velocity
- Free swell, semi-confined, and null swell tests for rocks and AAR reaction
- Test pit for conducting half- or full-scale tests of piles, tunnel segments and other elements



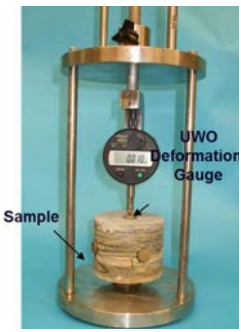
Resonant column device



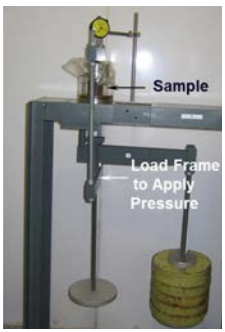
GDS cyclic triaxial device



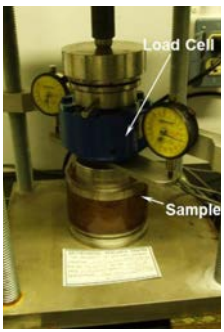
Advance cyclic ring shear testing



Free swell test



Semi-confined swell test



Null swell test

Tests for design parameters for underground structures in swelling rock

Clients and Projects

The following is a partial list of numerous past and present projects.

WRCT TUNNEL
Kentucky, United States of America
Clients: Hatch Mott MacDonald\Thelon Associates

ANKARA SUBWAY
Ankara, Turkey
Client: SNC-Lavalin

REHABILITATION OF HEART LAKE TUNNEL
Mississauga, Ontario
Clients: Ontario Ministry of Transportation\Thurber\RV Anderson\Golder\Morrison Hershfield

THE BOW
Calgary, Alberta
Client: Isherwood Associates

SAFETY EVALUATION OF MANY HIGH CONCRETE DAMS
Including Dams Along the St. Lawrence and Ottawa Rivers
Client: Ontario Power Generation (formerly Ontario Hydro)

FOUNDATIONS FOR WIND TURBINES
Southwestern Ontario
Clients: Hatch Energy\Boralex

SITE 'C' CLEAN ENERGY PROJECT
British Columbia
Clients: Klohn Crippen Berger\BC Hydro

BILLY BISHOP TUNNEL
Toronto, Ontario
Clients: EXP\Technicore

DESIGN OF INTAKE AND DISCHARGE TUNNELS
Darlington Nuclear GS, Ontario
Client: Ontario Power Generation

SITE EVALUATION AND CONCEPTUAL DESIGN
Darlington Nuclear "B", Ontario
Clients: AMEC\SNC Lavalin

DAM SAFETY EVALUATIONS, SEVEN SISTERS G.S.
Manitoba Hydro
Clients: Crippen Acres\Wardrop

EVALUATION OF CLIFF STABILITY, SIR ADAM BECK I & II, G.S.
Niagara Falls, Ontario
Client: Ontario Power Generation

ELECTROKINETIC CONSOLIDATION OF MINE TAILINGS
Toronto, Ontario
Clients: Cameco\Goldcorp\Golder\Ontario Power Generation

SEISMIC HELICAL FOUNDATION SYSTEM
London, Ontario
Client: EBS Construction

DEEP EXCAVATIONS FOR SHEPPARD SUBWAY
Toronto, Ontario
Client: Isherwood Geostructural Engineers

SEISMIC SOIL STRUCTURE INTERACTION ANALYSIS
Saudi Arabia, Thailand and United Kingdom
Client: Simon Carves, United Kingdom

VALE-FERRO CARJAS MINES
Brazil
Client: Worley Parsons

PORT ARTHUR POWER GENERATION
Texas, United States of America
Client: Tolunay Wong Engineers

FOUNDATION DESIGN AT NORTH POWER STATION
Bermuda
Client: Bermuda Electric Light Company Limited

Alumni

The following is a partial list of GRC alumni. The GRC has over 300 alumni. The position of the alumnus may have changed.

CHRIS D. THOMPSON, MESc'65
Technical Director, EXP Services Inc., Brampton

YUNG DUK KIM, PhD'70
Past President & CEO, Hyundai Corporation, New York

CHACK FAN LEE, PhD'72
Pro-Vice Chancellor, University of Hong Kong

K. TIM LAW, PhD'75
Professor, Department of Civil Engineering, Carleton University

DENNIS E. BECKER, PhD'81
Principal, Golder Associates, Calgary

HENRY CRAWFORD, MESc'84
Principal, Thurber Engineering Limited, Calgary

L.M. EL-HIFNAWY, PhD'84
Professor and Chair, Structural Engineering Department,
Alexandria University, Egypt

TOYO OGAWA, PhD'86
Chief Rock Mechanics Engineer, Taisei Corporation, Japan

ERNEST YANFUL, PhD'86
Professor, Department of Civil & Environmental Engineering
Western University

NADIR ANSARI, MESc'87
President and Designer, Isherwood Associates, Mississauga

YOUNG NAM LEE, PhD'88
Vice-President, GS Engineering and Construction Co. Ltd., Korea

CLEMENT YUEN, PhD'79
Senior Consultant, Golder Associates, Mississauga

FRANK BARONE, PhD'90
Principal, Golder Associates, Mississauga

BRIAN L.J. MYLLEVILLE, PhD'91
Senior Geotechnical Engineer, Principal, Golder Associates, BC

EDWARD SAN, MESc'91
Principal, AECOM

M. HESHAM EL NAGGAR, PhD'94
Professor, Associate Dean, Research and Graduate Studies
Department of Civil & Environmental Engineering, Western University

SEAN HINCHBERGER, PhD'96
Renewable Power Geotechnical Lead, Hatch, Niagara Falls

MICHAEL BALDINELLI, MESc'99
President, Baldinelli Consulting Limited, London

RICHARD BRACHMAN, PhD'99
Associate Professor, Geotechnical Engineering, Queen's University, Kingston

PAUL DITTRICH, PhD'00
Senior Geotechnical Engineer, Principal, Golder Associates
Mississauga

SILVANA MICIC, PhD'02
Senior Geotechnical Engineer, EXP Services Inc., Brampton

HANY EL NAGGAR, PhD'07
Assistant Professor, Department of Civil Engineering
New Brunswick University

JASON WECK, MESc'07
Engineering Manager, RWH Engineering Inc.

Corporate Members

The Geotechnical Research Centre has been in operation since 1985. Throughout these years, the centre has enjoyed long-term and continuous support from the industries. We cherish their support in pursuit of excellent engineering service.

Benefits for corporate members include: priority of services, access to pre-publication reports and papers, link to your company website, referral of graduate students, registration discount in short courses. To become a corporate member please contact Dr. K.Y. Lo at 519.661.2125 Annual membership is $250.

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cquintus@uwo.ca
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