

Geotechnical Research Centre

WESTERN UNIVERSITY, CANADA



Leading the field of geotechnical and
geoenvironmental engineering



Western
Geotechnical
Research Centre



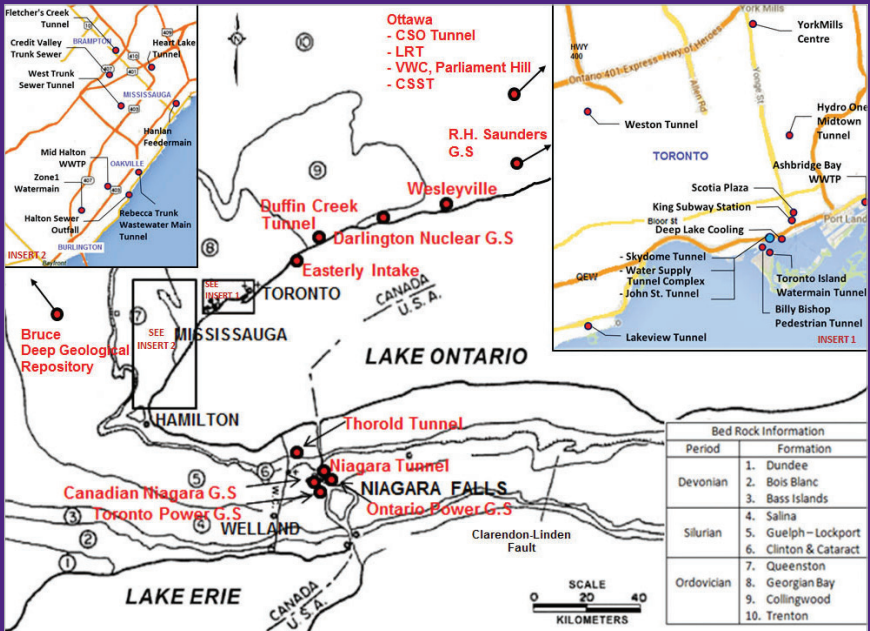
The Geotechnical Research Centre



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.

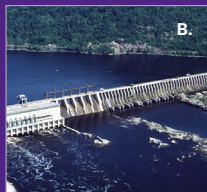
Map showing location of projects that utilized GRC methodology for testing and design of underground projects in Southwestern Ontario



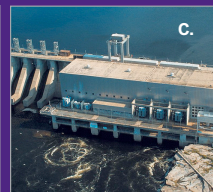
A. R.H.Saunders G.S.
St. Lawrence River



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 1985.

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 eight 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 eight 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 watermains, 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
- Innovative remediation technologies for contaminated soil and groundwater



Research Directors



KWAN YEE (K.Y.) LO, PhD, P.Eng., FEIC
Managing Director, Professor Emeritus
eng.uwo.ca/grc/kylo/kylo.html

Energy and Infrastructure 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, FASCE
Professor
eng.uwo.ca/civil/faculty/el_naggar_h/

Civil Infrastructure

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



JASON GERHARD, PhD, P.Eng.
Professor
eng.uwo.ca/civil/faculty/gerhard_j

Contaminant Hydrogeology and Site Remediation

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

**TIM NEWSON**, PhD

Associate Professor

eng.uwo.ca/civil/faculty/newson_t**Civil Infrastructure**

- Soft soil and clay engineering (including soil improvement)
- Offshore and energy geotechnics
- Buried structures and foundations
- Geotechnical physical modelling (1g & centrifuge)
- Static and dynamic laboratory testing of soil
- Constitutive (stress/strain) modelling of soils and structures

**CLARE ROBINSON**, PhD, P.Eng.

Associate Professor

eng.uwo.ca/civil/faculty/robinson_c**Contaminant Hydrogeology and Site Remediation**

- Groundwater-surface water interactions
- Fate and transport of contaminants in natural and engineered systems
- Green infrastructure
- Contaminant reactive transport modelling
- Geochemical modelling
- Water quality and supply in developing countries

Research Directors continued



ABOUZAR SADREKARIMI, PhD, P.Eng.
Assistant Professor
eng.uwo.ca/civil/faculty/sadrekarimi_a

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
eng.uwo.ca/civil/faculty/shang_j

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., FCSCE
Professor
eng.uwo.ca/civil/faculty/yanful_e

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
Global Discipline Director – Civil, Hatch, Niagara Falls

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, BE, PhD (Sydney), FCAE, FEIC, P.Eng.

Adjunct Professor, Civil and Environmental Engineering, Western University
Professor and Canada Research Chair in Infrastructure Engineering
Executive Director Geotechnical Centre at Queen's - RMC

G. NAKHLA, PhD, P.Eng.

TWNER Program Director
Salamander Chair of Environmental Engineering
Western University

M. L. NEHDI, PhD, P.Eng.

Professor, Civil and Environmental Engineering
Western University

R.K. ROWE, PhD, D.Eng., P.Eng., F.Eng., FRSC, FCAE, FEIC, FASCE, FIE (Aust), FCSCE

Adjunct Professor, Civil and Environmental Engineering, Western University
Professor and Canada Research Chair - Tier I, Queen's University

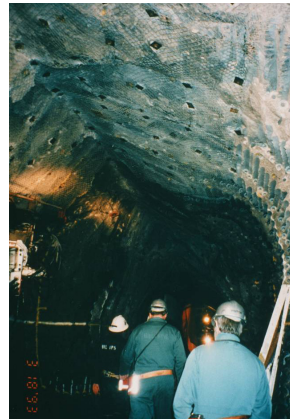
C. YUEN, PhD, P.Eng.

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 rock
- 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 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.

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

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
- Micromeritics 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

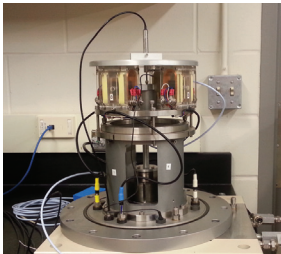
- Mercury intrusion porosimeter
- Gas chromatograph with mass spectrometer
- High performance liquid ion chromatograph
- Zeta potential and dynamic light scattering particle analyzer
- X-ray diffraction
- Pore water squeeze
- Inductive-coupled plasma optical emission spectrometer (ICP-OES)
- X-ray fluorescence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

STRUCTURES

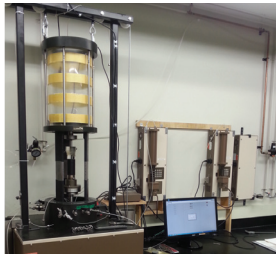
- Various compression and extension loading machines up to 1780kN compression and 960kN tension

GEOTECHNICAL

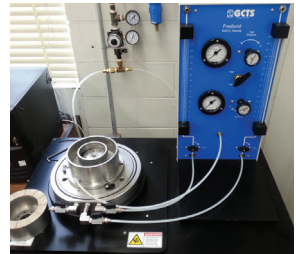
- Computer controlled fixed wall and flexible wall hydraulic conductivity
- Soil calibration chamber for controlled CPT and pile testing
- Experimental soil testing site for full-scale pile testing
- Computer controlled triaxial stress path systems (monotonic and cyclic)
- Resonant column device for 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
- Multidirectional cyclic simple shear: allows cyclic simple shear to be performed in two directions, rather than the standard single direction



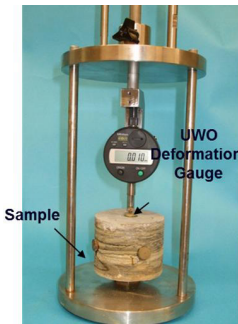
Resonant column device



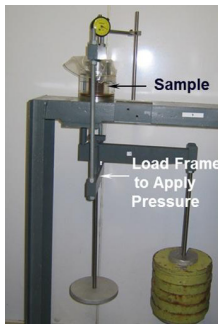
GDS cyclic triaxial device



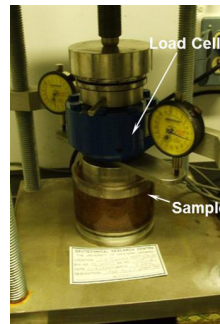
Advance cyclic ring shear testing



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 Geotechnical Engineers

SEISMIC SOIL STRUCTURE INTERACTION ANALYSIS

Saudi Arabia, Thailand and United Kingdom

Client: Simon Carves, United Kingdom

VALE-FERRO CARJAS MINES

Brazil

Client: WorleyParsons

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, MEng'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 Emeritus, Department of Civil Engineering, Carleton University

DENNIS E. BECKER, PhD'81

Principal, Senior Geotechnical Engineer, Golders Associates, Calgary

HENRY CRAWFORD, MEng'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

Senior Research Engineer, Taisei Corporation, Japan

ERNEST YANFUL, PhD'86

Professor, Department of Civil & Environmental Engineering
Western University

NADIR ANSARI, MEng'87

President and Designer, Isherwood Geotechnical Engineers, 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

Senior Geotechnical Engineer, Principal, Golder Associates, Mississauga

BRIAN L.J. MYLLEVILLE, PhD'91

Senior Geotechnical Engineer, Principal, Golder Associates, BC

EDWARD SAN, MEng'91

Senior Environmental Engineer, Golder

M. HESHAM EL NAGGAR, PhD'94

Professor, Department of Civil & Environmental Engineering,
Western University

SEAN HINCHBERGER, PhD'96

Global Discipline Director – Civil, Hatch, Niagara Falls

MICHAEL BALDINELLI, MEng'99

President, Baldinelli Consulting Limited, London

RICHARD BRACHMAN, PhD'99

Professor, Geotechnical and Geoenvironmental 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

Associate Professor, Civil and Resource Engineering,
Dalhousie University, Halifax

JASON WECK, MEng'07

President, RWH Engineering Inc., Ayr

Corporate Members



GROUND ENGINEERING CONSULTANTS LTD.
CIVIL & GEOENVIRONMENTAL ENGINEERS



Klohn Crippen Berger



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



Benefits for corporate members include: priority of services, 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.



Western
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