



# CPATT NEWS

Issue 10 - Winter 2014

## Message from the Director

HAPPY NEW YEAR TO EVERYONE!

We are very happy to be sending you our Issue 10 - Winter 2014 edition of our CPATT newsletter. We hope you all had a wonderful holiday and are ready to start the new year.

There are a few changes since our last newsletter, as you can probably see. We have a new format for the newsletter which we hope you like and find to be a it more user friendly. We also have a new CPATT logo.



We were also encouraged to update our look and come up with a new logo that is consistent with the new University of Waterloo guidelines. After collaborating with Creative Services at the University of Waterloo, we were able to develop the new logo. Thank you to all who assisted with this.

As many of you know, the Transportation Research Board Annual Meetings is fast approaching from January 12-16, 2013. The Civil and Environmental Engineering

Department with the Dean of Engineering will be hosting a special reception on **January 14, 2013 from 5:30pm-7:30pm** at the Washington Marriott Wardman Park Hotel, Stone's Throw Restaurant and Bar. This event is complimentary but registration is recommended. We look forward to seeing you there!

Also, upcoming training sessions for the new Transportation Association of Canada Pavement Asset Design and Management Guide will be hosted. See details on page 19. The first sessions start in January in Vancouver. Don't miss out!

Finally, we wish everyone a very successful and productive 2014. If you would like to learn more about anything we have presented in this newsletter, please do not hesitate to contact either Laura Bland at [lbland@uwaterloo.ca](mailto:lbland@uwaterloo.ca) or Susan Tighe at [stighe@uwaterloo.ca](mailto:stighe@uwaterloo.ca). We look forward to hearing from you!

Sincerely,

Susan L. Tighe, PhD., PEng  
Professor and Canada Research Chair  
Norman W. McLeod Professor in  
Sustainable Pavement Engineering  
Director of CPATT

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## Research Focus - Pavement Laboratory



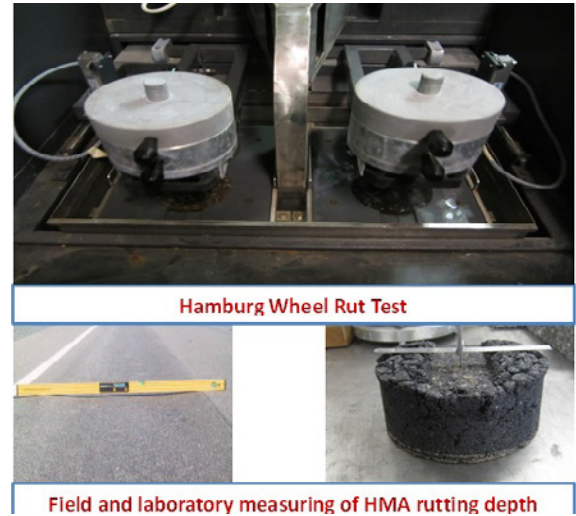
### Ministry of Transportation Projects

The Ministry of Transportation Ontario (MTO) is funding three research projects through the Highway Infrastructure Innovations Funding Program (HIIFP), which are currently on-going in the CPATT laboratory. The first project is to develop a database of the dynamic modulus ( $E^*$ ) for a wide range of hot mix asphalt (HMA) mixtures used in Ontario. Laboratory dynamic modulus tests will be performed on different mixtures that have been obtained from five Ontario regions. The material characterization laboratory data will then be used in the AASHTOWare software. In essence, the actual material characterization data will be used to predict pavement performance and will ultimately be compared with available pavement performance data for Ontario. The overall research findings are expected to be very important as Ontario moves toward using AASHTOWare for pavement design.



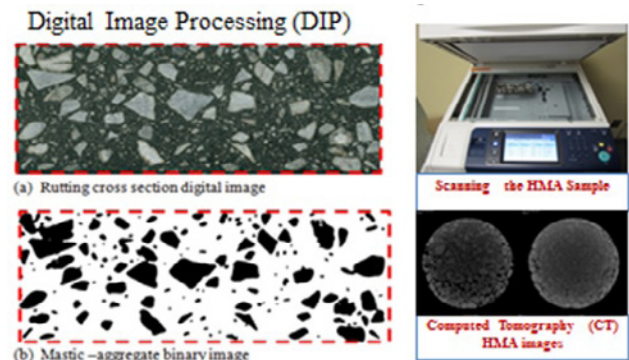
**Dynamic modulus test setup**

The second project is to improve the fatigue life of HMA without compromising rutting resistance which involves laboratory testing and performance. The fatigue resistance of four common Superpave mixes are being investigated by the four point bending test and hamburg wheel rut test (HWRT).



**Hamburg wheel rut test and measuring HMA rutting depth**

This research is aiming to reduce the discrepancies between the predicted and measured value for two common pavement distresses by using realistic modelling. The use of X-ray Computed Topography (CT) to identify the internal structure of asphalt mixes and build a realistic Finite Element model is also being researched .



**From top left: Rutting cross section digital image, scanning the HMA sample, mastic-aggregate binary image, and Computed Tomography (CT) HMA image**

## Research Focus - Pavement Laboratory



### Ministry of Transportation Projects Cont'd

The third project is to develop accepted test methods for performance and durability of pervious concrete pavements as well as to establish performance criteria for pervious concrete pavement tested for ravelling, abrasion, permeability, salt scaling resistance, and freeze-thaw resistance. It involves both laboratory and field testing. As pervious concrete pavement is a comparatively new practice in Canada, the main focus would be to find out how it performs with the frequent freeze-thaw cycles. Freeze-thaw resistance and scaling resistance will be tested using the freeze-thaw apparatus in the CPATT laboratory. For scale resistance testing, two types of deicing salts will be used. For the abrasion resistance testing, rotating cutters will be used. Along with these tests, flexural and tensile strength will also be tested. Mix proportions will be changed to improve the performance.



**Freeze-thaw testing in CPATT lab**



**Freeze-thaw testing**

For the field testing, light weight deflectometer and the british pendulum tester will be used. The overall expectation is to develop recommendations for mix design criteria, performance evaluation criteria, and the test methods for analyzing pervious concrete pavement in Canada.



**Barrie community parking lot - field testing**

## Research Focus - 4th Year Undergraduate Project



(Left to Right): Eric St. Pierre, Mert Ozsoy, Marcelo Gonzalez, Kevin Lai, and Dmitri Lozenko

### Comparison and Analysis of Concrete Membrane Systems

Since May 2013, a group of Civil Engineering undergraduate students consisting of Kevin Lai, Dmitri Lozenko, Mert Ozsoy, and Eric St. Pierre, have been working on their fourth year project in the CPATT laboratory under the guidance of Professors Susan Tighe and Scott Walbridge. In addition, PhD candidate, Marcelo Gonzalez and MSc candidate, Dan Pickel, have also assisted in the work. The group formed BAUSS Engineering to investigate the properties of several thin waterproofing membrane systems for protecting concrete surfaces and the goal of the work is to recommend the most sustainable waterproofing system for elevated concrete slabs in parking garages in the Greater Toronto area.

The group completed its economic, logistical and environmental analysis of the membrane systems in August 2013 based on several site investigations of existing installations and literature review. Currently, the group is in the process of analyzing the quality

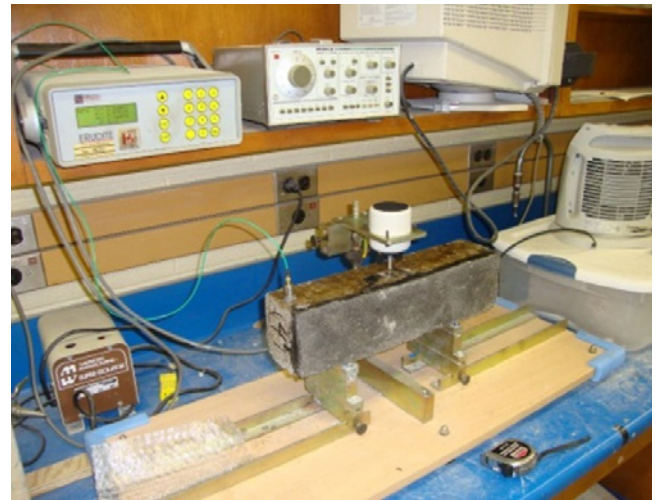
and performance of the membrane systems through several laboratory tests in the CPATT lab. With assistance from Marcelo Gonzalez and Dan Pickel, the group was able to fabricate 20 concrete rectangular prisms and 20 cylindrical concrete blocks.

The group contacted and received free product samples to work with from Tremco Inc., BASF Canada Inc., and Duochem Inc. The three companies are well-known thin membrane manufacturers in the Greater Toronto area. The provided product samples were: BASF's Conipur-E system, Duochem's DUODECK system, and Tremco's Vulkem system. With the assistance from Homestead Land Holdings Ltd., the group was able to acquire a sample of professionally applied mastic asphalt for application to the concrete slabs. Each product was applied separately on five concrete rectangular prisms and five concrete cylindrical blocks. Samples and the curing process are shown in the two pictures following.

## Research Focus - 4th Year Undergraduate Project



**Covering rectangular prisms**



**Natural frequency calculations**



**Cylindrical concrete blocks**

The next picture shows some of the natural frequency calculations. The 20 rectangular prisms are currently undergoing freeze-thaw cycles in the CPATT lab to analyze the effects of temperature changes on the concrete membranes systems.

The 20 cylindrical blocks will undergo abrasion tests in January 2014 to evaluate the wear resistance of the thin membrane systems. The group tested the products for skid resistance in the summer of 2013 by performing numerous British Pendulum tests on the four concrete membrane systems in-house in the CPATT laboratory. Also, they conducted these tests on-site on parking garage surfaces in London and Oakville, Ontario, respectively.

By the beginning of February 2014, the group is planning to have reliable results for abrasion tests, pull tests, skid resistance tests and freeze and thaw tests on all the four concrete membrane systems. The waterproofing system that proves to be most sustainable will be recommended for usage in parking garages throughout the Greater Toronto area after all the tests are complete and analyzed by April 2014.

## Research Focus - Concrete Laboratory



### Improved Methods for Predicting and Improving the Vibration Performance of Aluminum Pedestrian Bridges

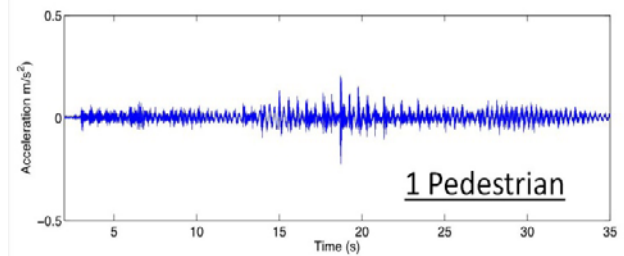
A UW Research project sponsored by the Aluminum Association of Canada (AAC), MAADI Group, and the Natural Sciences and Engineering Research Council of Canada (NSERC) is currently underway to develop improved methods for predicting and improving the vibration performance of aluminum pedestrian bridges. To date, field measurements have been conducted on the Daigneault Creek Bridge in Brossard, Quebec (44 m span) and the Bota Bota Bridge (13.7 m span) in Montreal.



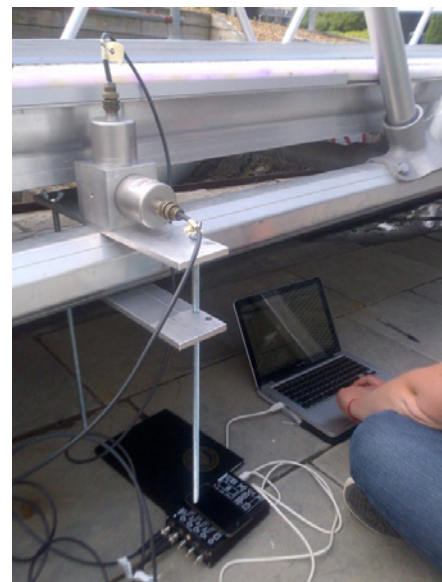
**Daigneault Creek Bridge**

Subsequently, a short span modular aluminum pedestrian bridge specimen has been installed and tested in the UW Structures Lab. This specimen is a shorter version of a 23 m (70') long specimen currently on order, which will allow vibration properties to be measured for a wide range of bridge configurations.

The use of the aluminum for pedestrian bridge construction can be advantageous due to its high corrosion resistance and strength-to-weight ratio in comparison with competing construction materials. In several recent examples, aluminum pedestrian bridges have been prefabricated, brought to site in one piece on flatbed trucks, and installed in remote area using small cranes, resulting in significant reductions in construction costs. Although low self-weight can be an advantage during construction, light weight pedestrian bridges are susceptible to vibrations from pedestrian loading.



**Sample Vibration Data**



**Bota Bota Bridge Data Acquisition**

## Research Focus - Concrete Laboratory Cont'd



The project underway at UW aims to develop improved loading models for flexible pedestrian bridge structures to address fundamental gaps in the current state-of-knowledge. In addition, this project aims to reduce aluminum pedestrian bridge construction costs by enabling more precise characterization of vibration behaviour (i.e. thorough improved understanding of the damping characteristics and loading) and design of vibration mitigating devices such as active or passive damping systems. It is expected that this will make longer span structures more economically feasible in the future.

Ann Sychterz and Pampa Dey are the UW graduate students currently working on this research project, in collaboration with Profs. Sriram Narasimhan and Scott Walbridge.

Some more pictures from this project can be seen below:



**Bota Bota Bridge Jump Test**



**Running Test on Short Span Laboratory Specimen**

## Research Focus - Professor Ric Soulis



### A New Tool to Calculate IDF Curves

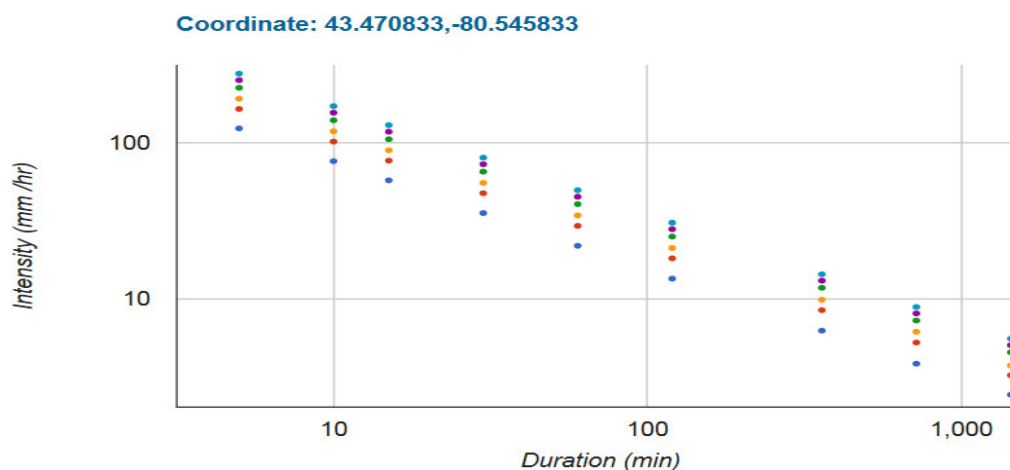
Good estimates of peak rainfall intensity are essential when designing highway drainage infrastructure such as culverts, bridges, sewer systems and roadside ditches. Quality rainfall data enables designers to make calculations that meet drainage capacity design standards and avoid the over or under design of drainage elements. Both can be expensive: over design may waste resources and under design can result in additional maintenance or repair costs.

Engineers are faced with the problem that data are only available for certain spots in the province. Data for other locations must be interpolated. This tool uses the latest Environment Canada data available from over 125 Meteorological Services of Canada (MSC) station across Ontario to determine rainfall intensities for any location in the province.

Ontario's Ministry of Transportation (MTO) recently updated the Rainfall Intensity Duration Frequency (IDF) Curve Look-up Tool in collaboration with Dr. Ric Soulis of the University of Waterloo. Historically, MTO provided IDF curves for each MTO District in a hard copy document developed with Environment Canada data up to 1989. It is essential to periodically update these IDF curves when additional data and new techniques become available to reflect climate change implications in a timely fashion.

Version 2.0 of the new web-based IDF Look-up tool was released in December 2013. This tool provides IDF curves electronically for any location across the Province and uses up-to-date data from Environment Canada. This tool is more robust, easier to use and provides confidence limits.

The IDF Curve Look-up tool uses the Square Grid Technique to estimate curves. The Square Grid Technique uses UTM grid squares as elementary sub-catchments.

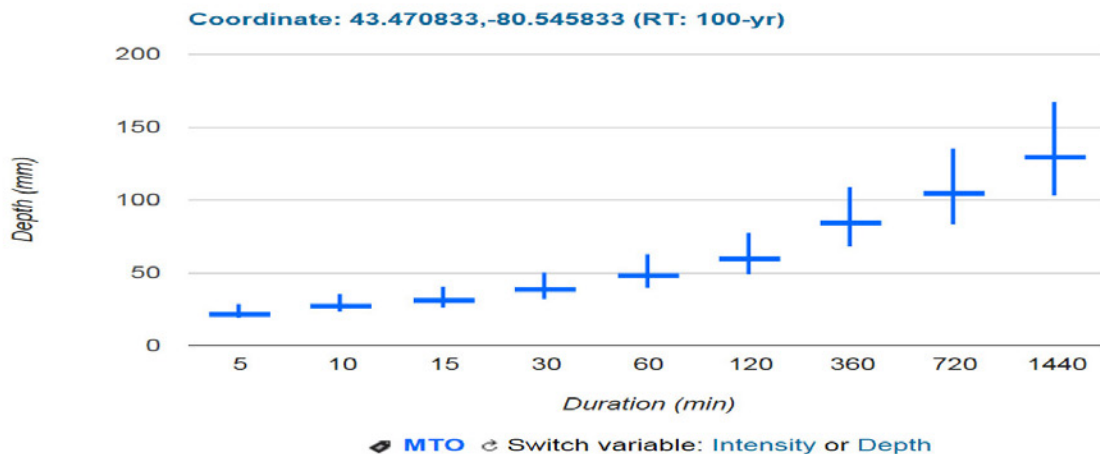


#### A sample IDF Curve showing 2-year through 100-year storms

The premise of the tool is that local climate is strongly influence by local and regional topography. Thus, topography parameters are useful interpolators of surface fields of interest, such as temperature, runoff and, in this case, IDF curve parameters A and B.



## Research Focus - Professor Ric Soulis Cont'd



### A Sample IDF Curve showing confidence limits for a 100-year storm

The USGS GTOPO-30 is used to derive physiographic characteristics that become independent variables in a regression analysis with station statistics. The regression analysis produces a set of generating equations for the parameters used to produce IDF curves. The technique weighs station data by their length of record to ensure that more reliable data have greater influence on the interpolation. The database consists of statistics from 127 stations with record lengths ranging from 11 to 103 years, with an average of 33 years.

The result is a gradually varying regional IDF curve. As regional curves and station curves both have uncertainty, the regional estimates are different than the station records. However, the 95% confident intervals overlap and the upper limit is generally higher than the mean station value. Both MSC local stations and regional values are available through Version 2.0 of this interface.

The new IDF curves are still project location based. The limits of a highway project are identified on the user interface by two representative locations. These locations are defined either by entering their latitude and longitude coordinates or by selecting the locations from the Google Maps interface.

With coordinates, the system identifies the IDF curve representative of these areas. The display shows the % error at the two identified points by assigning a representative colour to the icons. If the % error is greater than the acceptable value the highway section can be divided into two sections by adding a third intermediate point. This will result in dividing the highway project into two areas each with a different IDF curve.

The new IDF curve ensures that future highway drainage infrastructure designs are based on a more precise representation of recent weather patterns and can be reflective of any changes in the historic data. It will be easily updated as new rainfall data become available.

The interface tool is available through the [MTO Internet Website](#) as well as on the Provincial Highway Management, Drainage and Hydrology Intranet page.



## Student Feature - Karolina Konarski



### MEET KAROLINA KONARSKI

Karolina Konarski is a MSc candidate working in the Centre for Pavement and Transportation Technology. She has been a student at the University of Waterloo since 2012, when she began working towards her MSc in Civil Engineering with Professor Susan Tighe. Her expertise is in pavement engineering, particularly in structural pavement design, evaluation and pavement rehabilitation. She has been working at a consulting engineering firm as a pavement engineer since 2009, after completing her Bachelor's Degree in Civil Engineering from McMaster University.

#### **Feature Project - Mitigating the impact of climate change on runway pavement friction characteristics in Northern Canada**

In partnership with LVM, the University of Waterloo is conducting a research project where the general objective is to mitigate the impacts of climate change on runway surface friction characteristics. The testing for this project has been taking place at Kuujuaq airport, located in Northern Quebec, at one of Transport Canada's remote airports. As a result of climate change, the friction is decreasing on the runway pavement due to increasingly aggressive winter maintenance activities. The idea is to apply the outcomes of this research project to other Northern Canadian airports experiencing similar problems with runway friction.

The various components of this research project are as follows. Firstly, the existing condition of the runway pavement was examined by analysis of existing friction testing data obtained in previous years. Background data was gathered on surface friction as

related to runway pavements along with methods of measuring microtexture, macrotexture and friction on runways. In addition, background information was compiled as to various rehabilitation strategies to improve asphalt surface friction.

A program of laboratory testing was completed on asphalt samples obtained from Kuujuaq airport in order to assess the existing asphalt concrete mix used on the runway. Finally, an extensive program of field testing was completed consisting of measuring the micro and macrotexture, and friction of the runway using the GripTester instrument. The field testing results are currently being analyzed and compared to data from previous years to assess how the friction is changing over time. Recommendations will be developed to improve the pavement friction at Kuujuaq airport.

## Student Feature and Project Cont'd



### Feature Project - Mitigating the impact of climate change on runway pavement friction characteristics in Northern Canada - Pictures

Some pictures from the project that Karolina is working on are featured below



**Sand patch test in area of fatigue cracking on Runway 07-25**



**Runway winter maintenance activities - brooming operations**



**British Pendulum laboratory testing on samples of existing asphalt concrete from Kuujuaq airport**



**Findlay Irvine GripTester - Equipment used to measure friction on Runway 07-25**

## Student Feature - Dan Pickel



### MEET DAN PICKEL

- 2012 - Present: MASc. Candidate, Civil and Environmental Engineering, University of Waterloo
- 2010 - 2011: B.Ed., University of Western Ontario
- 2009 - 2010: Structural Engineer-In-Training, J.L. Richards and Associates Ltd. (Ottawa, ON)
- 2004 - 2009: BASc. Honours in Civil Engineering, Structural Option, with distinction, University of Waterloo

Dan Pickel is a MASc candidate working in the Centre for Pavement and Transportation Technology under the supervision of Drs Susan Tighe and Jeff West. He began his studies at the University of Waterloo in 2004 when he began working towards his BASc in Civil Engineering. He spend time working as a Structural Engineering Intern at a consulting firm in Ottawa, prior to earning his BEd in Intermediate and Senior Divisions Mathematics and Physics at the University of Western Ontario. He began his work with CPATT in 2012 following his interest in structural concrete and the usage of Recycled Concrete Aggregate in various applications.

Dan's work has resulted in the following awards:

- July 2013 - CCIL Scholarship - TAC Foundation
- 2012-2013 - QEII-Graduate Scholarship in Science and Technology - University of Waterloo



## Student Feature and Project Cont'd

### Feature Project - Saturation Effects and Benefits in RCA Concrete

In the past, millions of tonnes of demolished concrete would be put into landfills when concrete structures reached the end of their design life. This placed unnecessary high strains on the landfills, as well as the pits being quarried for “new” concrete aggregate. In the past decade, recycling of this demolished concrete has become more and more common across Canada after it was identified as a valuable asset which could be used to replace “high quality” aggregate in some applications with non-stringent requirements. These are frequently fill material or low-strength slurry applications.

While this is an excellent first step, recycled concrete aggregate (RCA) may have greater potential which is currently being under-utilized. Some RCAs have been used successfully in new concrete structures by replacing a portion of the natural aggregate during production. The variability of RCA poses challenges to its widespread usage in new concrete production and therefore a broader knowledge base for the material is required.

Dan's research aims to build upon the existing knowledge regarding RCA usage in the new concrete production with a focus towards the transportation applications which may be affected by RCA use.



Recycled Concrete Aggregate

Students helping Dan with casting concrete



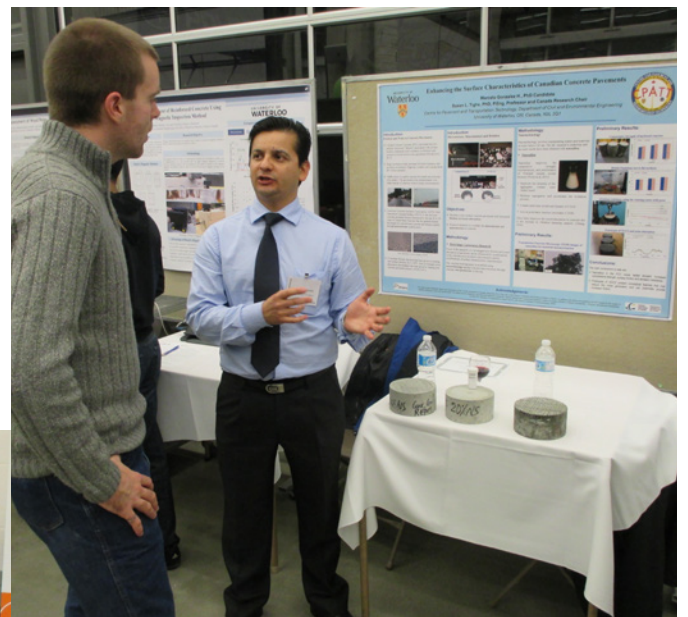
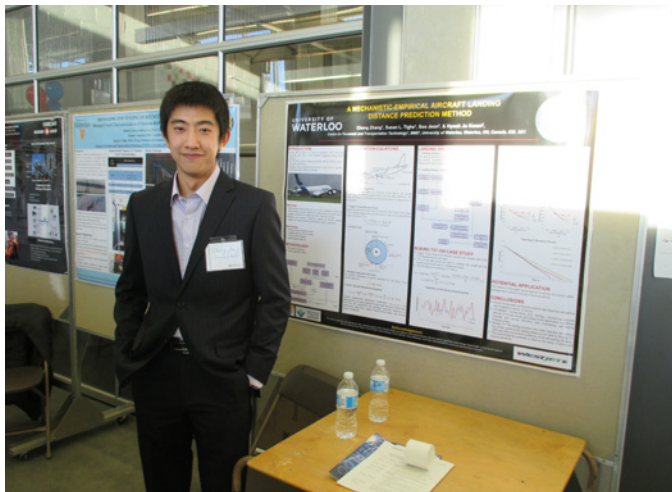
## WE Innovate



WE Innovate is a networking event held once a year by Waterloo Engineering. UW Researchers display emerging research in engineering. This year WE Innovate was held on Thursday November 14, 2013 in the E5 Adel Sedra Student Design Centre.

This event hosted two groups: UW undergraduate and high school students in the afternoon, and industry attendees, media and public at night.

Congratulations to all our presenters and to Marcelo Gonzalez who won the award for top 3 best projects.



Thanks for all those students and staff who participated on behalf of CPATT and thanks to Waterloo Engineering for hosting such a terrific event!

## Grade 5/6 Visit to CPATT



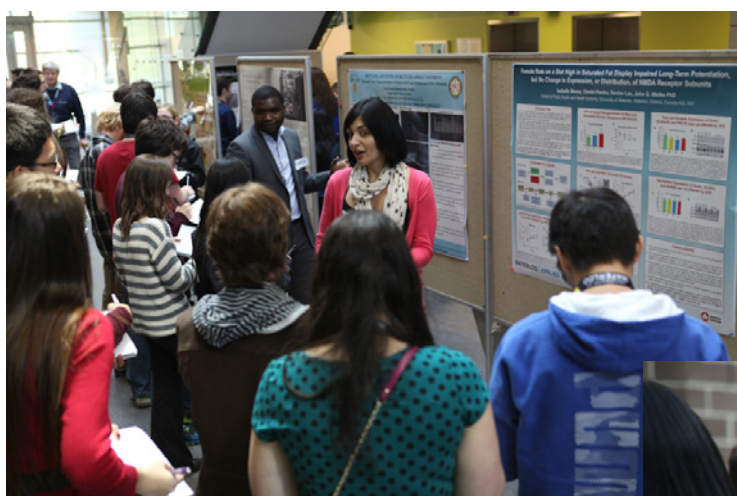
On Tuesday October 29, 2013 CPATT hosted a group of grade 5/6 students from Our Lady of Lourdes Elementary School. Many of the CPATT graduate students participated in this event by showing the students some of the projects underway in CPATT. The students were able to have a hands on experience in both the structures laboratory and the pavement laboratory at the Civil and Environmental Engineering Department at the University of Waterloo.



## Waterloo Unlimited Grade 12 2013 Program



Waterloo Unlimited is a university-wide high school enrichment program. They offer an enriched learning experience for high school students across Canada. On November 13, 2013, Doubra Ambaiowei (PhD candidate) and Andrew Northmore (MAsc candidate) under the supervision of Susan Tighe, participated in the Graduate Student Poster Display. UW students from across the facilities participated in this event to showcase their research and show high school students the exciting research happening at Waterloo.





## Awards and Upcoming Events




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### Awards and Recognition

**Roy W Crum Award - Ralph Haas** will be presented with the [Roy W Crum Award](#), the highest honour of the Transportation Research Board of the US National Academies at the TRB Annual Conference on January 15, 2014.

**J. Alan George Student Leadership Award** - This award was presented to **Gulfam Jannat**, a PhD candidate in the research group. This [award](#) is based on a record of outstanding student leadership.

**Bleed Black Award - Susan Tighe** received the inaugural Bleeds Black Award on December 11, 2013 at the 2013 Fall Asphalt Seminar hosted by the Ontario Hot Mix Producers Association. Susan received this award for her commitment to training and education to the industry. The best part, was the fact that it was a total surprise!



### Upcoming Events

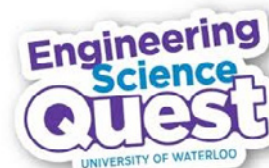
**January 12-16, 2014** - [Transportation Research Board 93rd Annual Meeting](#). This conference will be held at the Washington Marriott Wardman Park, Omni Shoreham, and Washington Hilton hotels in Washington, D.C. The UW Reception will be held during the TRB meetings.

**January - April 2014** - Transportation Association of Canada Seminars - Pavement Asset Design and Management Seminar - [Register Now](#) at on the TAC website. See page 19 for more details.

**2014** - Ontario Good Roads Association - Asset Management courses - see [website](#) for details

**January and February, 2014** - [Engineering Outreach Girls Club Mentor](#) - a couple of the CPATT female graduate students will be volunteering their time to mentor students between Grades 4 and 6 (Junior) and Grades 7 and 9 (Senior). The dates for these events are listed below:

Junior (grade 4-6)	Senior (grade 7-9)
January 25th - 1:00pm - 4:00pm	February 1st - 1:00pm - 4:00pm
February 22nd - 1:00pm - 4:00pm	March 1st - 1:00pm - 4:00pm
March 22nd - 1:00pm - 4:00pm	March 29th - 1:00pm - 4:00pm



## Norman W. McLeod Chair in Sustainable Pavement Engineering



We are very pleased to announce that the Canadian Asphalt Industries Inc. has become a member of the Norman W. McLeod Chair. We are very pleased to have them become a members of the Chair and look forward to working with them.

### New Faculty Position Advertisement



#### Pavement Engineering and Management

The Department of Civil and Environmental Engineering at the University of Waterloo invites applications for a tenure-track position in the area of pavement engineering and management at the Assistant or Associate Professor rank. The preferred candidate will have a research record in design, construction, maintenance and rehabilitation of flexible and rigid pavements, and expertise in one or several research areas such as modern pavement materials, pavement performance modelling, pavement instrumentation and evaluation, and materials testing. Ability to teach courses such as pavement structural design, infrastructure management, transportation engineering, construction or materials is an asset. The successful candidate must complement the recently established Endowed Norman W. McLeod Chair in Sustainable Pavement Engineering.

Applicants must have potential or proven ability to develop an internationally recognized research program, must have excellent communication skills, and must have a strong commitment to teaching at the undergraduate and post-graduate levels. In particular, the successful applicant must have a strong interest in innovative teaching methods and curriculum development to support our undergraduate civil, environmental and geological engineering programs. The ideal applicant should expect to work with public and private sector research partners, and generate collaborative research funding to lead a successful research program.

The successful applicant is expected to have an engineering license for practice in Canada or to apply for an engineering license with the Professional Engineers of Ontario within 5 years. Salary will be commensurate with qualifications and experience. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. The University of Waterloo encourages applications from all qualified individuals, including women, members of visible minorities, native peoples, and person with disabilities.

Interested applicants are invited to submit their full curriculum vitae, along with a teaching vision statement. They are also requested to submit a research vision statement, specifically indicating how their innovative research directions will complement the ongoing research in the Department of Civil and Environmental Engineering. Each of the vision statements should be no more than two pages in length. The curriculum vitae, vision statements and the names and full contact information of at least three references should be sent to:

Professor Neil R. Thomson  
Chair, Department of Civil and Environmental Engineering  
University of Waterloo, Waterloo, Ontario, N2L 3G1  
Email: [neil.thomson@uwaterloo.ca](mailto:neil.thomson@uwaterloo.ca)

**Note:** The screening of applicants is underway and we hope to have some news for you in the future newsletter.

## News



## Visitors

On December 6, 2013, Susan Tighe and CPATT hosted Tommy Edeskar and Sven Knutsson from Lulea University of Technology in Sweden, Sigurdur Erlingsson from the Swedish Transportation Institute, and Klas Kermelin and Johan Ullberg from the Swedish Transportation Administration.

Susan Tighe, Giovanni Cascante and Liping Fu, all professors at the University of Waterloo, gave presentations on their current research projects. We were very happy to host this visit and look forward to possible collaboration in the future.



## Other News

Aleli Osorio (PhD Candidate), working on her dual degree from the University of Waterloo and Pontificia Universidad Catolica de Chile (PUC), was featured in [Research Highlight](#) section of the Infrastructure Systems Committee (ISC) e-Newsletter.

Want to learn more about concrete grooving and pavement engineering in Canada. Check out the following links from CBC Radio which feature CPATT research. [Groovy Highways](#) and [Concrete and Asphalt Pavement](#).

## 2014 TAC PADMG SEMINARS

TAC offers seminars on most of its key publications. This seminar is for the new Pavement Asset Design and Management Guide. More information regarding these seminars can be found on the TAC [website](#). Please see below for the schedule:

Jan 27, 2014	Vancouver, BC	Member - \$495
Feb 11, 2014	Toronto, ON	
Feb 18, 2014	Edmonton, AB	Non-member - \$595
Feb 19, 2014	Calgary, AB	
Feb 20, 2014	Regina, SK	<a href="#">Register Now</a>
Feb 21, 2014	Winnipeg, MB	
Feb 25, 2014	Ottawa, ON	
Mar 04, 2014	Halifax, NS	
Apr 01, 2014	Moncton, NB	

## Contact Us



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## CPATT Board Members

Susan Tighe (Director) University of Waterloo  
Jeff West (Associate Director) University of Waterloo  
Rico Fung (Chair) Cement Association of Canada  
John Carrick Jr., McAsphalt Industries Ltd.  
Sandy Brown, Ontario Hot Mix Producers Association  
Becca Lane, Ministry of Transportation Ontario  
Matt Karan, Former Stantec Consulting Ltd.  
Carl Clayton, Stantec Consulting Ltd.  
Gary MacDonald, Regional Municipality of Waterloo  
Murray Ritchie, The Murray Group Ltd.  
Neil Thomson, University of Waterloo  
Ralph Haas, University of Waterloo  
Gerhard Kennepohl, University of Waterloo