



**CPATT**

CENTRE FOR PAVEMENT AND  
TRANSPORTATION TECHNOLOGY

# CPATT NEWS

Issue 15 - Spring 2016

## Message from the Director

**NORMAN W. McLEOD**

CHAIR IN SUSTAINABLE PAVEMENT ENGINEERING

Welcome to our Spring 2016 addition of CPATT News!

We hope all your projects have been successful to date and wish you all continued success as the construction season progresses.

We were delighted to celebrate 10 years of operation in the Fall 2015. In addition, we send a big thank you to Professor Jeff West who served as the Associate Director of CPATT from 2010 to 2015. Jeff's leadership and assistance in running CPATT was greatly appreciated and he will still remain an active member in CPATT. We welcome Professor Hassan Baaj as the new Associate Director who is already a very active member in CPATT and holds the Norman W. McLeod Professor in Pavement Materials. The contribution of all our active faculty and students really is at the heart of the success of CPATT.

The past decade has seen many research advances and achievements and we are grateful to all our active faculty members and research partners. In celebration, we have decided to feature one of our active collaborators, the Queensland Pavement Centre at the University of the Sunshine Coast, which is currently collaborating with CPATT on several initiatives.

In addition, in this newsletter we highlight some of the various projects underway at CPATT. Also, we highlight some events and special features.

Should you have any questions related to our activities please do not hesitate to contact us.

Sincerely,

Susan L. Tighe, PhD., P.Eng  
Professor and Norman W. McLeod Professor in Sustainable Pavement Engineering  
Director of CPATT

### Contents:

- Feature Faculty
- Student Feature
- Field Focus
- Individual Highlights
- Awards and Recognition
- Norman McLeod Chair
- Contact Us and Upcoming Events



University of the  
Sunshine Coast

## Faculty Feature - University of the Sunshine Coast

In 2015 Professor Tighe spent a portion of her sabbatical with the pavement engineering team at the University of the Sunshine Coast, near Brisbane, Australia. The small but enthusiastic team includes:

- Professor Mark Porter, Head of Discipline - Engineering
- Professor John Yeaman, Construction Engineering
- Associate Professor Greg White, Airport and Pavement Engineering

The University of the Sunshine Coast in Australia's faster growing University and in 2016 celebrated its the twenty year anniversary of its first lecture. The Pavement Engineering team may be small but it has grand visions and ambitions. Research activities are broadly divided into road pavement and airport pavement streams, with significant overlap in the areas of material characterisation and pavement instrumentation. Recent and current undergraduate and postgraduate projects and activities include:

- Analysis of data from full in-pavement temperature, moisture and strain instruments
- The impact of crude oil and bitumen changes on asphalt performance
- Comparing near surface stresses and strains with finite element and layered elastic models
- Premium binders for airport asphalt production
- Asphalt shearing and shoving in heavy aircraft braking zones
- Causes of top down cracking in asphalt pavements
- Modification to the ACN-PCN for identification of surface distresses in asphalt runways.

The University of the Sunshine Coast Pavement Engineering team welcomes the opportunity to strengthen ties with the University of Waterloo in the future and many collaborations are on-going. Despite the huge differences between Australia and Canada in terms of climate, there are many remarkable similarities in terms of designing long life infrastructure.



Mark Porter



John Yeaman



Greg White



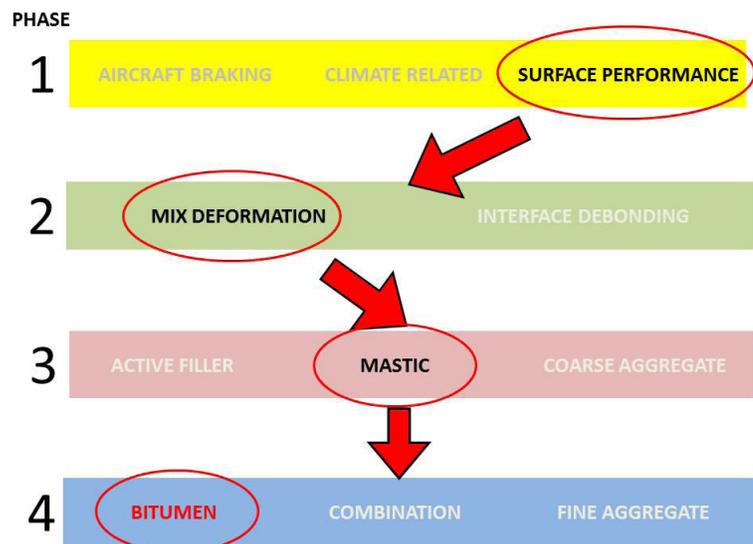
Faculty Feature - Greg White, USC

## Systematic Diagnosis of Factors Leading to Cyclic Shear Creep of Airport Asphalt Surfaces

Two runways at the same Australian airport were resurfaced with 50-60 mm of asphalt between September 2010 and July 2011. The Marshall-designed 14 mm nominal sized asphalt was typical of airport-quality asphalt in Australia. A premium acid modified binder, locally known as M1000, was used. Approximately six months after construction, horizontal shear creep deformations were observed. The failures were only observed in the braking zone associated with one landing direction and only on the second of the two resurfaced runways. Around 60 isolated failures presented over two to three years, after which, new failures ceased to appear.

At around the transition from one runway to the second, the fine aggregate (dust) source had changed from one quarry to another. The second dust contained predominantly Hisingerite clay minerals. Hisingerite is a rarely encountered member of the Smectite-group of clays and possesses physical properties indicative of potentially adverse effect on asphalt stability and shear stress resistance. The original dust contained Nontronite, a more common and less concerning member of the Smectite-group. Subsequent investigation determined that the bitumen (M1000) feedstock (crude oil source blend) also changed at around the transition between the two runways. Retained bitumen samples from before and after the feedstock change indicated significantly different bitumen properties. It followed that the two runways contained two substantially different mastics, within an otherwise common coarse aggregate skeleton. The aim of this investigation was to determine the single, or combination, of asphalt constituents that led to the significant difference in runway surface response to high shear stress conditions. The mastic (bitumen feedstock and dust source) was concentrated on. However, significant effort was also made to exclude other potentially contributing and confounding factors.

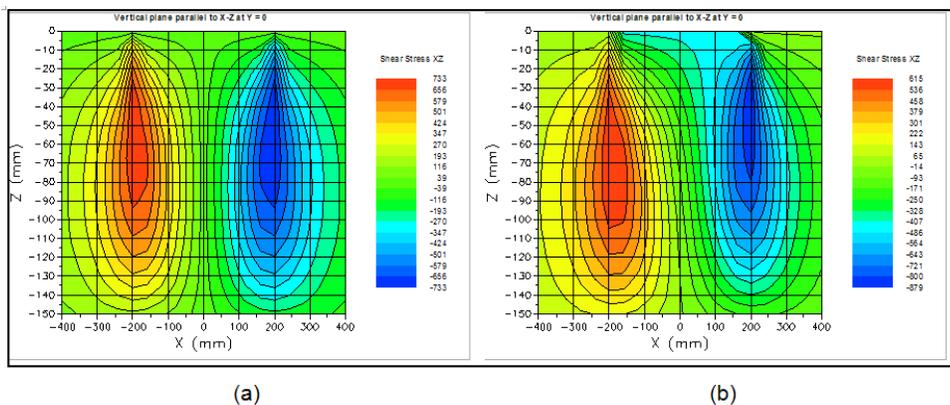
The initial phases of the systematic investigation confirmed the change in mastic was responsible for the observed difference in surface performance. First, aircraft-induced surface layer shear stresses were calculated for the three regularly used landing directions across the two runways. As a result, differential aircraft operation was excluded as a contributing factor. The figure to the right shows the phases of investigation leading to a change in bitumen properties as a root cause of distress.



## Faculty Feature - Greg White - Cont'd

Second, surface layer interface shear resistance was measured by direct shear and cyclic shear testing of cores recovered from the two runway surfaces. The direct shear testing excluded differential interface construction as a potentially contributing factor. The direct shear and cyclic shear test results were combined to demonstrate that the asphalt on the first runway had significantly higher resistance to cyclic shear stress than the second runway's asphalt. This focused the investigation towards the two asphalt materials and their constituents. Third, a range of non-specification testing was performed on the various retained and representative constituent materials. This excluded the coarse aggregate and hydrated lime (added filler) as contributing factors. The changes in M1000 feedstock and dust source were identified as the remaining possible factors

leading to the reduced shear stress resistance observed in the surface of the second runway. The figure to the left shows the shear stress with depth for (a) non braking aircraft and (b) extreme braking aircraft.



Finally, performance-based repeated shear stress testing of mastic and binder samples was used to isolate

the relative impact of the bitumen and dust changes on mastic, and therefore asphalt, shear resistance. Mastic testing showed that the change in dust source, and associated incorporation of Hisingerite clay, did not adversely affect the asphalt on the second runway. The impact of the feedstock change on the M1000 resistance to repeated shear stress was estimated from testing of retained bitumen samples. The M1000 bitumen incorporated in the second runway's asphalt showed lower resistance to deformation under repeated shear stress, as well as higher sensitivity to high stress levels.



It was concluded that the higher stress sensitivity and lower shear stress resistance associated with the bitumen used on the second runway resulted in an asphalt surface with reduced resistance to cyclic shear creep. Isolated zones of permanent horizontal deformation resulted under the high shear stresses associated with typical commercial aircraft braking. The observed self-correction of the surface was consistent with measured in-storage hardening of retained bitumen samples. The lack of resistance to shear creep of the second runway surface was determined to be an example of medium-term asphalt

tenderness, resulting from the change in M1000 feedstock. The figure to the left shows a typical (one of around 60) shear distresses in the aircraft braking one.



## Student Feature - Qingfan Liu



### Meet Qingfan Liu, PhD. P.Eng

After his PhD and MSc. Degrees from the Pavement Group at the University of Manitoba, Qingfan joined CPATT as a post-doctoral fellow, in the department of Civil and Environmental Engineering at the University of Waterloo under the supervision of Dr. Susan Tighe. Qingfan was able to receive prestigious scholarships during the course of his study and research including NSERC, TAC, CAPTG, and University of Manitoba Graduate Fellowship. He has published papers in the Transportation Research Record, the International Journal of Pavement Engineering, and the Canadian Journal of Civil Engineering. He has also been a technical reviewer for TRB, CJCE, Journal of Transportation Engineering, and the Canadian Institute of Transportation Engineers.

In his personal time, Qingfan is a avid gardener and shares his flowers and vegetables with his neighbours.

What does a safe, smarter, quieter, and sustainable pavement mean to the society? While different pavement professional may have different opinions or approaches, Qingfan has been working on this field for more than a decade and he will be continuing working on it as his chosen career. Pavement surface characteristics at the macro-texture and micro-texture scale are critical to vehicle stability, traction, friction, and road noise. Unfortunately, the high cost and complexity of friction/texture testing equipment, together with legal liability issues have meant that transportation departments conduct few and limited friction and noise testing and that deficient pavement surfaces could be in service for many years without being inspected. In an effort to address these issues, Qingfan conducted numerous tests to investigate pavement texture in a three-dimensional (3D) manner by using a line-laser scanner of which the sampling interval and accuracy of texture measurement is better than 0.05 mm to cover partly both macro-texture and micro-texture. The advantage of the line-laser scanner is that pavement surface texture is recovered into 3D surface texture height maps and providing more realistic assessment of surface texture than two-dimensional profile methods. His field tests and analysis cover various types of pavement:

- Collected and analyzed texture data for 28 types of asphalt and concrete pavement at MnROAD facilities, Minnesota Department of Transportation, USA.
- Evaluated pavement texture, friction, and noise for 14 types of new constructed rigid pavement sections at the South Extension of the I-355 North-South Tollway between I-55 and I-80 Joliet, Illinois, USA.
- Investigated the impacts of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) on pavement performance for Manitoba highways and local streets in Winnipeg.
- Assessment the texture and friction values for the runways of the James Armstrong Richardson International Airport, Winnipeg.
- More than 100 sensors were installed into Manitoba highways to monitor roadway response under various loading conditions including In-situ moisture, strain, temperature, and deflection.
- Conducted non-destructive road tests e.g. falling weight deflectometer, tire footprint pressure control and measure systems.



## Student Feature - Peter Mikhailenko



### Meet Peter Mikhailenko

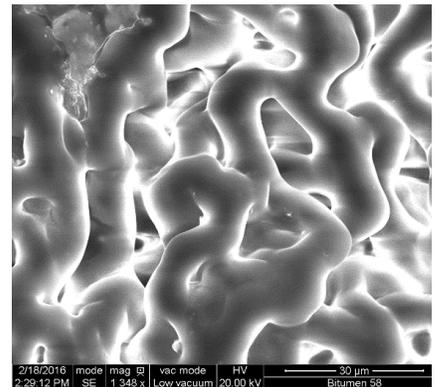
Peter Mikhailenko is a Research Associate in CPATT, having started in January 2016. Born in Kiev, Ukraine SSR, he immigrated to Toronto, Canada at a young age with his family. Peter owes his very existence to research, as his optical engineer parents met during a project on laser-optics.

Peter completed his B.Eng and MASC degrees at Ryerson University in Toronto in Civil Engineering and his PhD in Civil Engineering at the Toulouse III Paul Sabatier in France. He also has experience in the concrete industry, notably with St Mary's

Cement. He started his interest in building materials by performing research on cementitious materials at Ryerson. During his undergraduate period, he worked on zero-slump concrete. He worked on self-healing concrete and cement paste with high levels of metakaolin for his Master's Degree.

Peter's work on bituminous materials began during his PhD project in Toulouse, France. The project focused on the transformation of biological waste into construction materials - including an asphalt release agent and rejuvenating agent - the development of which comprised Peter's PhD project. The collaborative project involved several university research laboratories, R&D companies along with construction material producers and users in France. Peter's role was to above all, develop the test methods that would allow for the characterization, the performance and safety of these agents, followed by their testing and evaluation. This resulted in Peter developing the most comprehensive program for evaluating asphalt release agents that exist today. He also worked on microscopic techniques for evaluating bitumen aging and rejuvenation; including FTIR Microscopy and SEM. Peter defended his PhD in July 2015.

Peter has published his PhD work in journal articles and at conferences. Having been exposed to research in bituminous materials, Peter came back across the Atlantic to continue this research path with the CPATT team. Peter's role involves work on research projects in asphalt materials as well as aiding fellow researchers within CPATT. Peter's current and future projects involve binder extraction and recovery, asphalt aging, pavement cracking, RAP blending, asphalt self-healing and the observation of asphalt with ESEM (pictured above), ensuring that he will be a busy person. Peter is very excited to be a part of the CPATT team.





## Field Work Focus - U-Fill Project

Recycling Concrete Aggregate (RCA) and Reclaimed Asphalt Pavement (RAP) are construction materials produced from existing structures which have reached the end of their service lives. RCA is typically produced by crushing concrete which has been broken up while RAP is typically produced by cold-milling asphalt pavement. RAP is frequently recycled into new pavement structure, often being replaced on the same roadways from which it was milled. RCA is more often used as a replacement for virgin material in granular fill applications, but has been found to be usable in new concrete applications as well.

RCA generally has a high content of fine material due to the crushing operation. This fine material is generally made up of the fine aggregate and cement mortar of the original concrete material. When it is included in new concrete, the fine RCA materials greatly increase the water demand and can reduce the material's workability and compressive strength. For these reasons, this fine fraction is often reduced or removed prior to including RCA.

Unshrinkable fill (u-fill) is a concrete mixture which is characterized by its highly flowable nature and its low compressive strength. In order to achieve these characteristics, it is designed with a high water content and low cement content. U-fill is often used to fill around buried utility lines as it can flow beneath the lines and be easily excavated when the lines need to be reached in the future.

Because of u-fill's low requirement for strength and already high water content, it could represent an potential application wherein the use of recycled materials is not detrimental.

The City of Toronto is interested in determining if recycled materials can be effectively used in u-fill applications. Specifically, they are interested in

recycled materials which include the fine fraction, unlike some previous applications. If this material is usable in u-fill, then a significant processing step can be removed making recycled materials a more attractive alternative to virgin materials. Depending on the results of the study, they may modify their municipal construction specifications to allow for recycled material's inclusion in u-fill. The City put together a research team including the Centre for Pavement and Transportation Technology, consultants from LVM, and the Miller Group to investigate this question.

The research program has included several iterations including two field trials and several laboratory trials. CPATT has undertaken these lab trials investigating the effect of recycled materials on workability, compressive strength, bleed water amount and bleeding time, and bearing strength.



**Bearing testing of u-fill**

## Field Work Focus - U-Fill Project Cont'd



---

The recycled materials themselves were tested for their gradation, absorption, density, specific gravity, and freeze/thaw durability.

The recycled materials consisted of a combination of RCA and RAP, which was generally referred to as recycled aggregate (RA). The relative amount of each was initially varied between 100% RCA/0% RAP, 70% RCA/30% RAP, and 50% RCA/50% RAP. In later iterations, the 50/50 blend was used to replace 0%, 25%, 50%, and 75% of the virgin granular material.

The RA was found to greatly affect the bleeding rate of the material, which is significant for a material like u-fill with high water content. This also affected the bearing capacity of the materials as a significant amount of water remained at the material's surface layer for considerably longer periods of time.

Field trials were undertaken where trenches were excavated and subsequently filled with u-fill. These trenches were allowed to sit for four hours and were then paved over. The pavement was then loaded to test for material's bearing capacity.

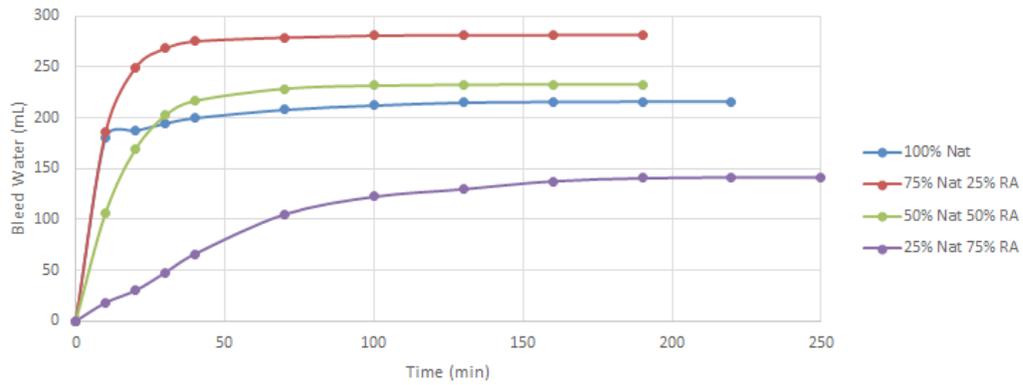
The results of the lab and field tests indicate that u-fill produced with up to 25% RA can perform similarly to u-fill produced with 100% virgin aggregate. Beyond this level, the bearing capacity of the material at the age of four hours was not sufficient to support the construction loading that would be required in the field.

The City of Toronto is currently looking into incorporating these findings into its construction specifications.

Please see the next page for more images of this project.



# Field Work Focus - U-Fill Project Cont'd



Bleed rates for varying RA level u-fill



Bleeding and conditioning laboratory samples



Placement of u-fill during field trials

## Highlights - Friend of the Faculty Award Miller McAsphalt Group 2015 recipients



The Faculty of Engineering established the Friend of the Faculty award in 2005 to provide tangible recognition to an individual, company, organization, group, or foundation for their support of the Faculty of Engineering. The 2015 award was presented to The Miller McAsphalt Group. They were recognized for their ongoing commitment and generous support to Waterloo Engineering that was instrumental in the launch of the Centre for Pavement and Transportation Technology and the Norman W. McLeod Chair in Sustainable Pavement Engineering.

The Miller McAsphalt Group partnership with the University of Waterloo dates back to the 1970s. It was John Carrick Sr. and Leo McArthur that began the partnership with the University of Waterloo Civil Engineering department back in the early 1970s. At this time, Dr. Norman McLeod was the Vice-President of Asphalt Technology at McAsphalt and also taught the 4th year pavement design course for nearly 20 years.

It was in the late 1980s that the Norman McLeod Engineering Professorship was established which Dr. Ralph Haas held for many years. From the relationship between Dr. Haas, John Carrick Sr, Leo McArthur, and Dr. McLeod came the creation of the Centre for Pavement and Transportation Technology. The Norman McLeod Professorship has now grown into a fully funded endowed Chair with 16 public private partnerships whereby Dr. Susan Tighe holds the senior Chair and Dr. Hassan Baaj holds the junior Chair.

Miller McAsphalt have collaborated with CPATT on many research projects and continues to do so today and are committed to continued research and the training of highly qualified people which have included many engineers working for them through the UW co-op program and have hired many students after their graduation.

Congratulations to the Miller-McAsphalt Group. Sadly, we also acknowledge the passing of Leo McArthur in January 2016. We greatly appreciate all of Leo's contributions and we will miss him.



**Pictured at ceremony (left to right): John Carrick Jr., Blair McArthur, and Kelly Carrick**

## Highlights - Graduate Poster Symposium



On Friday October 30th, we held the 5th annual Graduate Student Poster Symposium in the E5 Sedra Student Design Centre. There were a total of 16 student posters. Industry members, faculty, staff and students attended this event and were able to provide great feedback to the students.

Congratulations to the three winners for the best posters and interesting research. Ben Dow for his research on development and study of UHPC as a closure strip material in prefabricated bridge applications, Magdy Shaheen for his research on the effects of high friction aggregate and PG plus on surface hot asphalt mixtures rutting: laboratory and image based characteristics, and Colin Van Niejenhuis for his research on stainless steel reinforcing alloys corrosion.

Thank you to all the students that participated in this event, the industry, faculty and staff that attended and our three judges: Anton Kucharek (McAsphalt Industries Ltd.), David Rhead (Ministry of Transportation Ontario), and Mick Prieur (Concrete Ontario).



## Awards and Recognition



---

## Awards and Recognition

**2015 Irene Marguerite McLeod Award - Zaid Alyami**

**2015/2016 Ontario Graduate Scholarship - Dan Pickel-** Awarded for excellence in the graduate program

**2015/2016 Ontario Graduate Scholarship - Sina Varamini-** Awarded for excellence in the graduate program

**2016 Sze Memorial Award - Dan Pickel-** Awarded for research in the field of experimental stress analysis.

## New Baby

Congratulations to Aleli Osorio, former CPATT PhD Student and her husband Pancho on the arrival of their beautiful baby girl, Jasmin Espinosa Oso rio. She was born on June 14, 2015 in Chile.



## Norman W. McLeod Chair in Sustainable Pavement Engineering



### New Members



Shenglin Wang started his Ph.D. in September 2015 at the Centre for Pavement and Transportation Technology under the supervision of Prof. H. Baaj. He obtained his Bachelor's degree in Civil Engineering from Hefei University of Technology (in China) at 2011, and Master's Degree of Geotechnical Engineering from Lanzhou University (in China) at 2015. Shenglin's research topic focuses on the use of Hydraulic Road Binder (HRB) for subgrade stabilization under effects of freeze-thaw cycles. During his spare time, Shenglin enjoys reading, playing soccer, basketball, Ping-pong and spending time with family and friends. Shenglin is a recipient of the China Scholarship Council (CSC) Scholarship in addition to several other distinctions during his studies in China.



Yashar Azimi started his Ph.D in September 2015 at CPATT under the supervision of Prof. H. Baaj. Yashar received his Bachelor's and Master's degrees in 2004 and 2008, respectively from Isfahan University of technology (IUT) and University of Tehran, Iran. He has seven years of professional research experience in the field of asphalt materials including production, modification, characterization and application.

The focus of his research involves the analysis and characterization of aging process in asphalt binder and accelerated laboratory aging methods to predict the aging behaviour of asphalt pavements. His research project is supported by the Ontario Ministry of Transportation (MTO) through the Highway Infrastructure Innovation Funding Program (HIIFP).

## Norman W. McLeod Chair in Sustainable Pavement Engineering



### Farewell



After one year spent at the Centre of Pavement and Transportation Technology as Research Associate, Dr. Prabir Das has accepted, last December, an interesting job offer as Pavement Specialist with SNC-Lavalin in Vaughan, Ontario. The management and the members of CPATT would like to thank Prabir for his great efforts during the last year and for his very precious contributions to our research projects. We also wish him great success in his new career and wish to keep strong ties with him in the future as his unique expertise and knowledge would certainly be valuable in different research projects. On behalf of the Director and the members of CPATT, Prof. Baaj presented to Prabir a small gift as a souvenir from his colleagues during the OHMPA's annual seminar in December 2015.

### Norman W. McLeod Advisory Board

Susan Tighe (Norman W. McLeod Professor), University of Waterloo  
 Hassan Baaj (Norman W. McLeod Associate Professor), University of Waterloo  
 Amir Halim (Board Chair), Stantec Consulting Limited  
 Bruce Armstrong, Canadian Asphalt Industries Inc.  
 Larry Wilson, Capital Paving Inc.  
 John Pontarollo, CRH Canada  
 Mohammed Ahmed, DBA Engineering Ltd.  
 Michael MacKay - EnGlobe  
 Ludomir Uzarowski - Golder Associates Ltd.  
 John Carrick Jr., McAsphalt Industries Limited  
 Blair McArthur, Miller Paving Limited  
 Becca Lane, Ministry of Transportation Ontario  
 James Smith, Ontario Good Roads Association  
 Sandy Brown, Ontario Hot Mix Producers Association  
 Mick Prieur, Concrete Ontario  
 Ted Arscott, Roto-Mill Inc.  
 John Emery, Shiloh CanConstruct Ltd.  
 Malcolm Matheson, Steed and Evans Limited

## Contact Us and Upcoming Events



University of Waterloo  
200 University Avenue W.  
Waterloo, ON  
N2L 3G1  
[www.civil.uwaterloo.ca/CPATT/](http://www.civil.uwaterloo.ca/CPATT/)

### Numbers and Email:

Dr. Susan Tighe, Director  
519-888-4567 ext. 33152  
[sltighe@uwaterloo.ca](mailto:sltighe@uwaterloo.ca)

Dr. Hassan Baaj, Associate Director  
519-888-4494  
[hassan.baaj@uwaterloo.ca](mailto:hassan.baaj@uwaterloo.ca)

Laura Bland - Office  
519-888-4567 ext. 32289  
[lbland@uwaterloo.ca](mailto:lbland@uwaterloo.ca)

CPATT - Laboratory  
519-888-4567 ext. 37731

## CPATT Board Members

Susan Tighe (Director) University of Waterloo  
Hassan Baaj (Associate Director) University of Waterloo  
Rico Fung (Chair) Cement Association of Canada  
Tony Kucharek, McAsphalt Industries Ltd.  
Sandy Brown, Ontario Hot Mix Producers Association  
Becca Lane, Ministry of Transportation Ontario  
Matt Karan, Former Stantec Consulting Ltd.  
Amir Halim, Stantec Consulting Ltd.  
Gary MacDonald, Regional Municipality of Waterloo  
Murray Ritchie, The Miller Group Ltd.  
Neil Thomson, University of Waterloo  
Ralph Haas, University of Waterloo

## Upcoming Events

June 1-4, 2016 - [CSCE Annual Conference](#) - London, Ontario

September 19-22, 2016 - [SWIFT World's Premier Airfield Operations Conference](#) - Minneapolis-St. Paul

September 25-28, 2016 - [Transportation Association of Canada Conference and Exhibition](#) - Toronto, ON

November 13-16, 2016 - [Canadian Technical Asphalt Association](#) - Banff, AB