CPATT
CENTRE FOR PAVEMENT AND TRANSPORTATION TECHNOLOGY

CPATT NEWS

Issue 17 - Fall 2016

NORMAN W. McLEOD
CHAIR IN SUSTAINABLE PAVEMENT ENGINEERING

Message from the Director

Welcome to our Fall 2016 addition of CPATT News!

We hope all your projects have been successful throughout the construction season. One of our major highlights is our recent collaboration with the University of Auckland in their Climate Adaptation Research Platform. The initiative is designed to address the challenges associated with climate adaptation.

Contents:

In this newsletter we highlight some of the various projects underway at CPATT including work with concrete overlays, reclaimed asphalt pavement, and high modulus asphalt concrete. Also, we highlight some events and special features from the past few months which include a seminar by Curtis Berthelot from PSI Technologies Inc., Susan Tighe's University of New Brunswick lecture, Dr. Marcelo Gonzalez seminar, graduate student awards and new students starting with CPATT/Norman W. McLeod Chair in Sustainable Pavement Engineering.

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

Please note that Laura Anderton is away on maternity leave and in her absence Jessica Rossi will be out Research Financial Administrative Assistant. We wish Laura well and will look forward to having Jessica join the team.

Sincerely,

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

UNIVERSITY OF WATERLOO

Faculty Feature - Dr. Carl Haas

Carl Haas, PEng, PhD, FCAE, FASCE, FNAC

Carl Haas is the Tier 1 Canada Research Chair in Construction and Management of Sustainable Infrastructure and a Professor and Interim Chair in the Department of Civil and Environmental Engineering at the University of Waterloo, Canada. His research, teaching and consulting are in the areas of advanced construction and transportation technology, sustainability, and construction productivity. He has received several research and teaching awards. He has supervised 38 Doctoral and 67 Masters students to completion, and has over 375 publications including over 150 refereed journal articles. He serves on a number of editorial boards and on professional committees for organizations such as the American Society of Civil Engineers (ASCE), the Transportation Research Board (TRB) and the International Association of Automation and Robotics in Construction (IAARC). At the Transportation Research Board, he served as Chair of the committee on Applications of Emerging Technologies (A2F09, 1996-2002), as a member of the Group 2 Council on Design and Construction of Transportation Facilities (2003-2006), and as a member of the committee on Construction Management (AFH10). His research has been supported by numerous companies including: Aecon, PCL, KLA Tencor, Coreworx, SNC Lavalin, OPG, GSE&C, Software Innovation, Dupont, Hilti, Houston Lighting and Power, Fluor, Crafco, EPRI, the Construction Industry Institute (CII) and their member companies, as well as agencies such as TxDOT, MTO, NSERC, NSF, CRC, etc. He is a member of the Canadian Academy of Engineering and a Fellow of the ASCE.

He was elected to the US National Academy of Construction in 2013. In 2014, he shared the Construction Industry Institute Outstanding Researcher of the Year Award with Paul Goodrum and Carlos Caldas, and he received the CSCE Walter Shanly Award for outstanding contributions to the development and practice of construction engineering in Canada. In 2015, he received the ASCE Peurifoy Construction Research Award, the premier international career award in construction research.

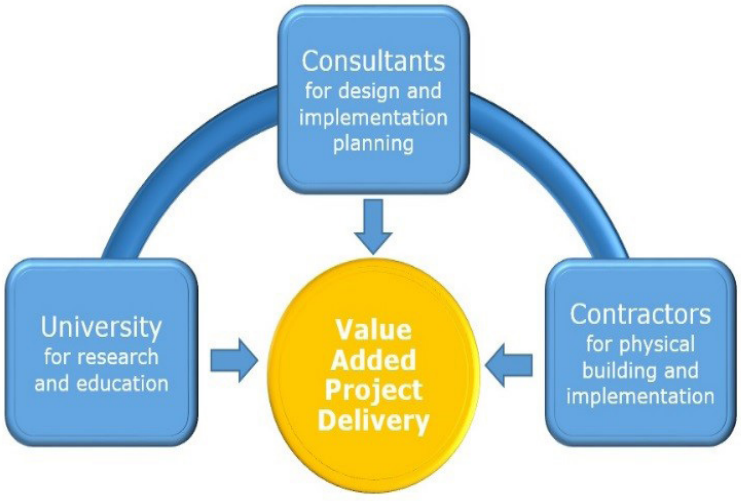
Carl has worked with colleagues and MTO on Weigh-in-Motion technology, automated road condition sensing, and most recently on risk management for highway projects with Prof. Chris Bachmann. Other current research interests include construction robotics, 3D imaging, construction productivity improvement, risk management for complex projects, and system dynamics modeling for sustainable infrastructure strategies.

CPATT joint initiative with University of Auckland

Although the distance between the University of Auckland and the University of Waterloo is approximately 13,879 km, that did not stop these two universities collaborating on research and teaching. For the past five years, Professor Susan Tighe has been involved with the University of Auckland with research, teaching on the Transportation post graduate programme and assisting with the examinations of Masters and PhD research. In return, Susan has also been working with Dr. Theuns Henning and Dr. Seosamh Costello with some research in Canada, most recently on a performance management project with the Ministry of Transportation Ontario (MTO).

CPATT has also recently joined the Climate Adaptation Research Platform, an initiative of the University of Auckland. This initiative has been set up to address the challenges of climate adaptation particularly in Asia Pacific, a region were the impacts of climate change are predicted to hit hardest. New Zealand's geographical proximity, close government level relationships and deep cultural knowledge and understanding of the region puts the University of Auckland in a unique position to help and this is the first step to doing so.

The issues related to climate adaptation are too large to tackle alone and therefore the platform has been built around establishing partnerships with engineering and consulting companies (in New Zealand) and other universities, such as the University of Waterloo. This approach allows the insights from the latest research from universities to be combined with the practical experience and delivery of engineering and construction consultancies to achieve the highest value outcome to the end user.

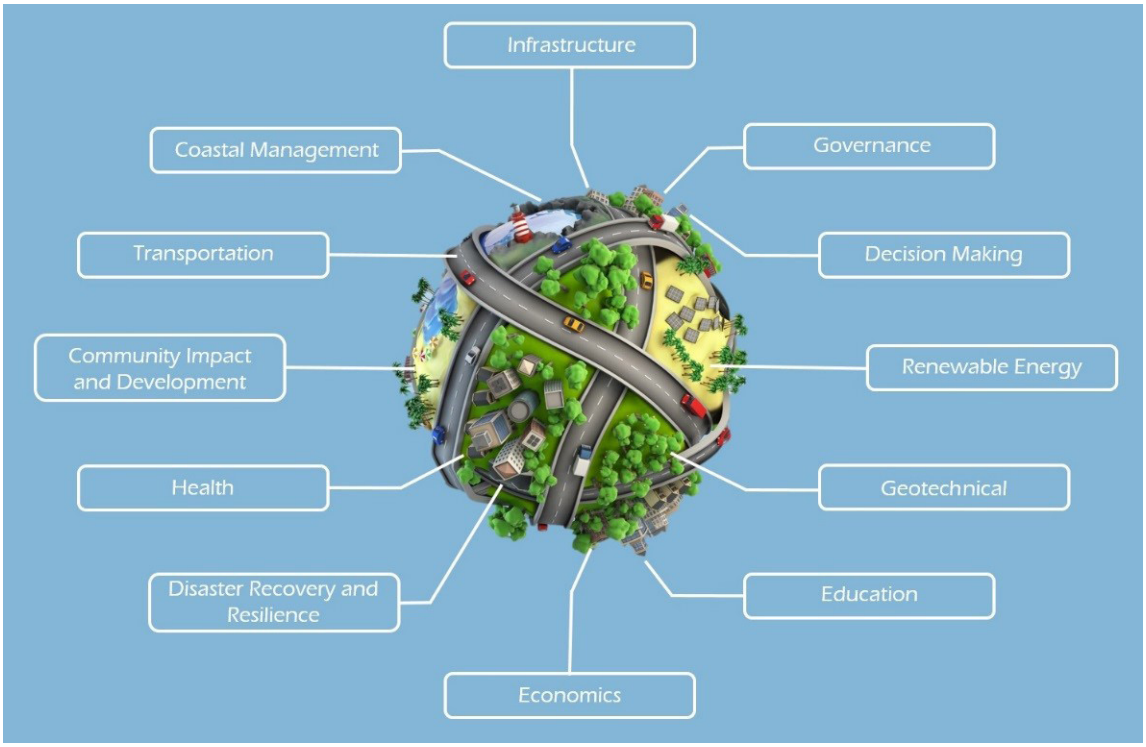


This image is of the climate adaptation research platform - creating value to multi-sector partnerships.

The platform has a strong multi-disciplinary focus which brings together leading engineers and researchers from transportation and infrastructure, structural engineering, geotechnical engineering, hydrology and coastal engineering, building management, disaster responses and resilience, to economics, human and development sciences, and population health. The goal of the platform is to bring together the best team, to provide the best solutions for those in need. Therefore, the platform will as a group be looking out for opportunities to which we can contribute, these will include opportunities with the World Bank and the Asian Development Bank.

CPATT joint initiative with University of Auckland Cont'd

The first platform related project has already taken place with the development of a technical note that considers the integration of Climate Adaptation into Road Asset Management (Footnote to Ref). In this project, asset management processes such as data collection, decision making and life-cycle analysis were reviewed to determine how better to take account of climate change impacts on road infrastructure. This work was carreid out for the World Bank and involved collaboration between Dr. Theuns Henning and Dr. Susan Tighe.



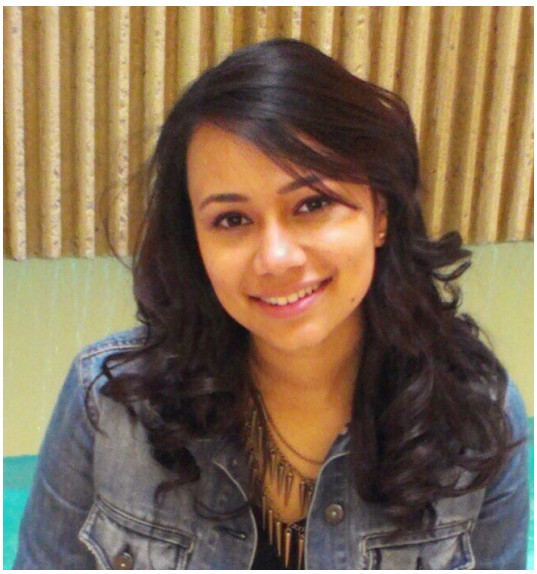
The Climate Adaptation Research Platform - A global multi-disciplinary focus

The Climate Adaptation Research Platform greatly values the knowledge and expertise of CPATT and sees this collaboration enhancing the relationship between the two universities but more importantly the collaboration will help provide greater global support for those in need of climate adaptation solutons.

Ref - Hemming, T.F.P., Greenwood, I.G., Tighe, S.L. (2016) Integrating Climate Change into Road Asset Management - Technical Report for the World Bank. The World Bank Group, Washington, DC. (To be published).

Student Feature - Raha Wafa

Meet Raha Wafa



Raha is a MASc. candidate in the Department of Civil and Environmental Engineering at the University of Waterloo, under the supervision of Dr. Susan Tighe. Raha grew up in Toronto and attended Ryerson University for her Bachelors in Civil Engineering (B.Eng). She completed her degree in 2013 focusing on structural engineering and began working for the City of Toronto. In the span of three years, she has experienced working in many divisions within the City of Toronto such as water, transportation and engineering, and construction services. Some of her projects include working on preventative measures for basement flooding, wastewater treatment plant designs and installation of street furniture within the GTA. Her last position sparked an interest in the field of transportation engineering and the CPATT lab. She joined CPATT in January 2016. Raha is also the current treasurer for the University of Waterloo ITE Student Chapter.

Raha's Project

CPATT was contacted by the City of Hamilton with a request for a preliminary proposal. The proposal was to include preliminary designs for a pilot project involving concrete overlays of existing composite pavements on residential streets in Hamilton. For her MASc project, Raha will be working with the City of Hamilton on the feasibility of concrete overlays to rehabilitate these streets.

The Yeoville neighbourhood in Hamilton consists of several streets with composite pavements; Jameston Avenue between Upper James Street and West 5th Street, has been identified as the most suitable candidate for this project. Based on preliminary inspections, many distresses along the road have been identified such as longitudinal cracks, setting of catch basins, deterioration of saw-cuts, etc. Initial repairs have been done on the street using mill-and-replace. However, underlying joints in the concrete layer have propagated to the asphalt layer creating distresses.

Once the asphalt layer is milled off, the existing condition of the underlying concrete will determine if a bonded or unbonded overlay will be used. A bonded overlay is typically used for pavements without severe distresses that can easily bond to the existing concrete and act monolithically.

Student Feature - Raha Wafa Cont'd

Raha's Project Cont'd

Unbonded overlays do not rely on the existing pavement for flexural capacity. A separation layer is placed between the existing pavement and the overlay to isolate the two layers. In the past, this separation layer has been comprised of either a nonwoven geotextile or a thin (≤ 25mm) layer of high stability asphalt. Once the type of overlay is determined (bonded or unbonded), strain gauges will be installed at the interface between the concrete and the asphalt separation layer or existing concrete. These gauges will provide insight into the strain behaviour at the bottom of the unbonded overlay. The strains observed will be both static and dynamic in nature. The strain data from these sensors will be used to assess how the interface between the overlay and the underlying pavement is behaving. Differences in the behaviour of bonded and unbonded would be of interest to determine the efficacy of the interlayer bond and differences between the strains of hot mix asphalt (HMA).

The main deliverable to the City of Hamilton will be the development of a design guideline for the use of concrete overlays on their municipal streets, which could be applied to their numerous neighbourhood street maintenance and resurfacing contracts across the city.

Yeoville Neighbourhood Street

Student Feature - Amma Wakefield

Meet Amma Wakefield

Amma Wakefield is excited to rejoin the CPATT team as a PhD Candidate in the Department of Civil and Environmental Engineering at the University of Waterloo, under the supervision of Dr. Susan Tighe. Amma was born and raised in Ghana, and immigrated to Canada with her parents and brother in 1995. She completed her BEng in materials engineering at McMaster University, and began her career in materials testing and pavement design. Two years later, she enrolled in a Master Degree on a part-time basis researching the long term performance of warm mix asphalt at the University of Waterloo, under the supervision of Dr. Tighe. She completed her Master's Degree in 2011, has published papers in the Canadian Technical Asphalt Association Journal, and has been a technical reviewer for the Journal of Transportation Engineering.
Amma enjoys sharing knowledge and always promised to give back to her native country. Since 2009, she has been going to Ghana, teaching in seminars about cold-in place recycling, hot mix asphalt mix design methods, materials testing, and quality control, at Ghana Institute of Engineers, and at Kwame Nkrumah University of Science and Technology through Zoomlion Ghana Limited.

Amma is currently working with Aecon Materials Engineering while pursuing her PhD, managing quality for design-build projects. Prior to this she worked for Miller Paving Limited as Manager of their Materials Research lab and Design, and Lafarge Canada as a Product Development Specialist.

In her personal time, Amma enjoys gardening, lifting weights, and spending time with her husband and 5-year old son. She also shares some of the interesting things she learns on an instagram blog: @HitTheRoadWithAmma.

While the details of her PhD thesis are being finalized. Amma is working with a fellow PhD candidate, incorporating recycled concrete aggregates in hot mix asphalt. Amma is excited to be part of the CPATT team once again, and is looking forward to sharing more of the things she will be learning on this new journey.

Amma with a group she taught HMA mix design to through the Ghana Institute of Engineers in June 2015.

Lab Work Focus

Sustainable Alternative Materials in Unbound Granular Layers

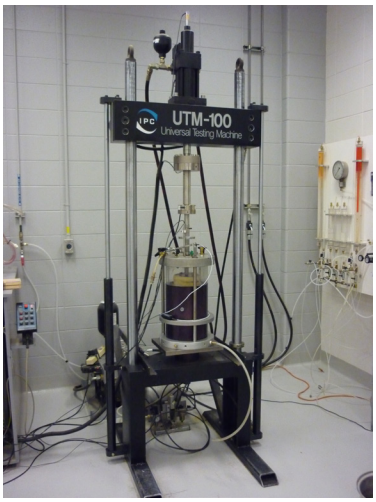
The use of sustainable alternative materials as construction aggregate has increasingly been taking on greater importance in the pavement industry, as natural aggregates are growing in scarcity in developed urban areas and substantial supplies exist of recycled concrete aggregate (RCA), reclaimed asphalt pavement (RAP) and other post-consumer materials. It is crucial to properly characterize these materials so that their properties are known for both current and future engineering applications.

One such project at CPATT centers on the characterization of foam glass lightweight aggregate (LWA), conducted in partnership with Foamyna Canada Inc. and with support from the Ontario Centres of Excellence (OCE). Initial laboratory work proceeded in 2015, including grain size analysis, crushed particle content, flat and elongated partial content and Micro-Deval abrasion resistance testing in CPATT's John J. Carrick Laboratory at the University of Waterloo. In January 2016, freezing and thawing resistance testing was carried out on samples of the foam glass LWA materials.

LWA samples undergoing freeze-thaw resistance testing

The researchers would like to thank Mr. Terry Ridgway, Fluid Mechanics, Hydraulics and Structures Technician with the Department of Civil and Environmental Engineering, for his assistance and the use of space and equipment in his lab facilities.

More recently, a partnership was undertaken with the Université Laval in Quebec City, QC to complete resilient modulus testing on samples of the foam glass LWA materials from Foamyna. In general, resilient modulus testing examines the response of the compacted material to applied cyclic loading stress under varying levels of confining pressure, which is simulated by housing the sample under a loading piston in a sealed chamber containing compressed air. The apparatus then cycles through a range of fifteen different axial and confining pressure states to obtain a series of resilient modulus values for the material under investigation.



Resilient modulus apparatus at Université Laval

The long drive to Quebec City was well worth it, and many thanks go to research associate Jean-Pascal Bilodeau, undergraduate engineering student Marielle Fauteux and Professor and Canada Research

Lab Work Focus

Sustainable Alternative Materials in Unbound Granular Layers - Cont'd

Chair Guy Doré for their invaluable assistance and for the use of their equipment and facilities at Université Laval. The information gathered will aid in upcoming preliminary design work on aggregate layers to be composed of foam glass LWA.

Compacted LWA sample ready to be transferred into the resilient modulus apparatus

Another research project ongoing at CPATT is examining the potential use of RCA and RAP as aggregate in Granular B Type II materials. Ontario Provincial Standard Specification (OPSS) 1010 permits the use of RCA, RAP and other recycled materials in a range of granular fill classifications, but currently specifically prohibits their usage in Granular B Type II. This research is being carried out in partnership with the Ontario Ministry of Transportation (MTO), Aggregate Recycling Ontario (ARO), and a number of private-sector contributors including Lafarge Canada Inc. (a division of Lafarge Holcim), Steed and Evans Ltd., R.W. Tomlinson Ltd., and Nelson Aggregate Co.

A combined field and laboratory testing program was carried out in 2015 on a range of Granular B Type II test blends incorporating varying proportions of natural aggregate, processed RCA and processed RAP. Field trials including test pad construction and examination proceeded in the summer of 2015 at quarry sites owned by R.W. Tomlinson Ltd. in Ottawa, ON and Nelson Aggregate Co. in Burlington, ON. This was followed by laboratory testing conducted primarily at the Lafarge Canada Inc. Innovation and Training Centre (ITC) in Toronto, ON, which included grain size analysis, standard and modified Proctor, permeability, California Bearing Ratio (CBR) and resilient modulus testing.

More recently, this project was presented at the February 2016 combined conference of the Ontario Good Roads Association (OGRA) and the Rural Ontario Municipal Association (ROMA), held at the Royal York Hotel in Toronto, ON. This was followed by successful acceptance and presentation of a paper on the field testing program at the June 2016 annual conference of the Canadian Society for Civil Engineering (CSCE) in London, ON. Another technical paper on the laboratory testing program has been accepted for publishing and presentation at the 2016 annual conference of the Transportation Association of Canada, to be held in Toronto, ON from September 25-28.

For more information, please contact Adam Schneider, MASc Candidate or Professor Hassan Baaj

Lab Work Focus

High Modulus Asphalt Concrete Mix Design

An on-going project at CPATT is the development of high modulus asphalt concrete mix design technology based on Ontario's conditions such as climate, traffic loading, and availability of materials and specifications.

High modulus asphalt concrete, or Enrobé à Module Élevé (EME) in French, represents a category of asphalt mixes which has a very high stiffness modulus (dynamic or complex modulus) together with excellent resistance to rutting and to fatigue cracking. It was developed in the 1980s in France to address the problems of rutting and premature fatigue cracking in flexible pavements. The use of EME mixes in the pavement structure would lead to a better distribution of stresses and strains in the different layers of the pavement.

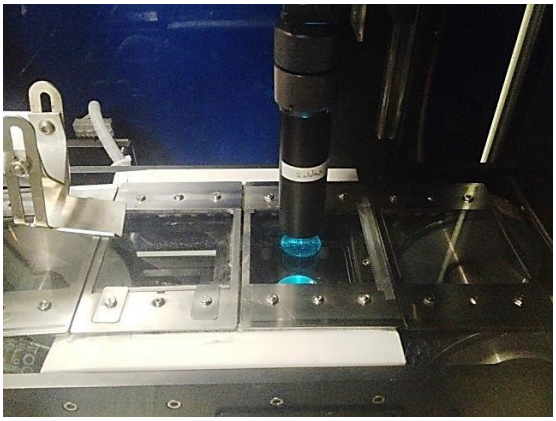
Basically, the high stiffness of EME mixes comes from two components:

1. reinforced granular structure; and
2. hard asphalt cement.

EME modifier (pellets with polymers)

In this study, the Compressive Packing Model (CPM) is used to address the first component. CPM has been developed and used for high performance cement based concrete materials. Therefore, it is being used in the field of asphalt concrete for the first time. For the second component, highly polymer modified binder is utilized in order to prevent from premature fatigue and low temperature cracking of asphalt concretes. The aggregate morphologic parameters are also determined using the aggregate image analyser. The purpose of this test is to evaluate the effects of aggregate shapes on performance of EME mixes.

For more information please contact Taher Baghaee or Professor Hassan Baaj.



Obtaining aggregate morphologic parameters

Asphalt cement modification

Highlights, Awards and Recognition

CPATT Picnic 2016

On Friday July 15th, the CPATT group met in Waterloo Park for a potluck picnic. All the students have been very busy with their projects and thesis writing so it was a great way for the group to decompress and have a good afternoon to interact outside of school.

Awards and Recognition

2016 Department of Civil and Environmental Engineering's Special Recognition Award - Dan Pickel- Awarded for excellent teaching support provided to undergraduate students in the Winter 2016 term

2016 UW Graduate Scholarship - Dan Pickel and Hanaa Al-bayati - Awarded for excellent academic progress outlined in the Winter 2016 Activity Report

2016 TAC Student Paper Award - Adam Schneider - first place winner

Upcoming Events

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

Norman W. McLeod Chair Update
Marcelo Gonzalez Seminar

On July 8, 2016, CPATT and the Norman W. McLeod Chair hosted a seminar with Dr. Marcelo Gonzalez as the guest speaker. Dr. Gonzalez is an Assistant Professor at the Pontificia Universidad Católica de Chile (PUC). He received his PhD from the University of Waterloo in 2014, his Master of Science from the PUC in 2006 and his Bachelor of Civil Engineering from the Universidad de Santiago de Chile in 2002. Before his PhD, he was a researcher and consultant for 6 years at DICTUC (a branch of the PUC). He has also held consultant jobs in countries such as Chile, Argentina, Peru and Panama.

Dr. Gonzalez is a member of the Basic Research and Emerging Technologies Related to Concrete, AFN10 Transportation Research Board. He is also an associate researcher at the Research Center for Nanotechnology and Advance Materials CIEN-UC. Finally, he is leading the creation of the first Center of Concrete Innovations in Chile, which will be located at PUC.

Marcelo's Presentation

Portland Cement Concrete (PCC) is the single most widely used material in the world. According to a report of the Strategic Development Council from the USA, the common objectives in the PCC industry are: "deliver a high-quality, long-lasting, competitive, and sustainable product". In order to achieve those objectives, the PCC industry is facing some challenges such as process improvements, product performance enhancements, energy efficiency, sustainability and technology transfer, among others.

The climate change and the rapid growth of the world population has severe impacts on natural resources. For instance, according to the report of the World Health Organization, by 2025, more than half of the world's population will be living in water-stressed areas. Also, the rapid growth of the world population is having severe impacts on pollution, which is affecting both water and air.

In addition to the global problems, Chile is facing local issues associated mainly with the lack of fresh water and natural aggregates. Also, big underground mining projects will be built in the future to produce minerals such as copper and they will need a significant amount of PCC. Since two natural resources for PCC are fresh water and natural aggregates, the concrete industry in Chile may face some complexities associated with the scarcity of natural resources.

Dr. Gonzalez's presentation can be found here

Norman W. McLeod Chair Update
Steve Goodman - Adjunct Professor

Dr. Steve Goodman is honoured to join his alma mater as an Adjunct professor. Dr. Goodman's post secondary career started with a Bachelor of Applied Science in Civil Engineering from the University of Waterloo in 1997. As his highest mark was achieved in 4th Year Pavement Engineering, he arranged a meeting with Dr. Ralph Haas to discuss options for entering the industry. Dr. Haas recommended graduate studies at Carleton University under the supervision of Dr. Abd El Halim - a former Waterloo graduate specializing in pavement research and the developer of the AMIR roller. Dr. Goodman entered the Masters program at Carleton in 1998 after an 8-month stint at Stantec where he was responsible for the analysis of pavement management data for clients such as the Ontario Ministry of Transportation and the New Jersey Department of Transportation. Dr. Goodman's Masters thesis was funded by the US Transportation Research board's IDEA program and involved the design, fabrication and testing of an in-situ shear strength/stiffness test for hot mix asphalt. During his Master's degree, Dr. Goodman worked for the Canadian Strategic Highway Research Program (C-SHRP) where he was responsible for technology transfer of new research results from US-SHRP across Canada.

After extensive discussion with his supervisor, Dr. Goodman entered the PhD program at Carleton in 2001 with a focus on the surface characteristics of pavements - specifically texture and friction. His professional and personal lives also changed when he joined the City of Ottawa as Senior Pavement Engineer and married his fiancee Carla in 2002. Seven years later, he successfully defended his PhD thesis concerning non-contact image analysis of pavement friction and texture, as well as comprehensive analysis of the mix properties that most contribute to pavement surface characteristics.

Between 2008 and 2015, Dr. Goodman started and successfully managed the Ottawa office of Aecon Material Engineering to provide engineering support to Aecon operations in Eastern Ontario and internationally. In September 2015, he joined Houle Chevrier Engineering Ltd. to manage their growing pavements and materials group in Ottawa and provide technical support to their parent company GEMTEC across Atlantic Canada.

Through his 18 years of experience with a national technical association, a large municipality, a major contractor, and now a dynamic consulting firm, Dr. Goodman has gained significant experience in all aspects of pavement engineering including design, rehabilitation, management, preservation and materials. During this time, Dr. Goodman also indulged his interest in teaching by acting as a sessional lecturer at Carleton University for both graduate and undergraduate courses on numerous occasions. His passion for research has also led to the publication of over 20 technical papers.

Since 2006, Dr. Goodman has been the Editor for the Canadian Technical Asphalt Association (CTAA) and is responsible for reviewing, formatting and publishing their annual conference proceedings. As editor and a member of the Board of Directors of CTAA, Dr. Goodman regularly interacts with pavement professionals from across Canada. His editing experience was also utilized by TAC when he was retained to review and edit the 2013 Pavement Asset Design and Management Guide - a national effort led by Dr. Susan Tighe.

Outside of work, Dr. Goodman enjoys travelling, golf, spending time with his family and occasionally relaxing although his four year old daughter Sabrina keeps him perpetually entertained and active (exhausted actually). As an Adjunct Professor with UW, Dr. Goodman hopes to continue his passion for research and teaching by becoming more involved with the education and training of the next generation of pavement engineering professionals.

Norman W. McLeod Chair Update
CIVE 740 Class Field Trip

The Cive 740 (Innovative and Sustainable Materials in Civil Engineering) graduate class field trip took place on July 12, 2016. The students had the opportunity to visit the limestone aggregates quarry equipped with an environmentally friendly aggregate washing system. The next step in the visit was the asphalt batch plant. The plant manager gave a general presentation of the plant and its components followed by a visit to the control room where the students had an explanation of the fully automatic operation of the plant. Next, was a tour of QC laboratory of Steed and Evans where concrete and asphalt mix designs are conducted and production samples are tested to ensure that they comply with standards and specifications.

Lastly, the students were taken to the ready mix concrete plant where the students listened to an explanation by the plant manager on the plant operations and the transportation of concrete to the job sites.

The field trip was very informative and interesting and fulfilled its anticipated objectives. This field trip completed the theoretical knowledge that the students acquired in the classroom and helped them to better understand the manufacturing and operational side of some of the civil engineering materials. The students and the course instructor, Prof. Hassan Baaj, would like to thank Steed and Evans, and in particular Jim Karageorgos, Manager of the materials division of the company, for this great opportunity!

Norman W. McLeod Chair Update
New Students

Meet Haya Almutairi

Haya started her PhD in January 2016 at CPATT under the supervision of Prof. Hassan Baaj. She received her Bachelor and Master's degrees in 2007 and 2013, respectively, from Kuwait University. In addition, Haya also has six years of practical experience as a civil engineer with the Ministry of Public Works in Kuwait in the road design and maintenance department. Haya's research is part of a research program aiming for the development of High-Performance Asphalt Mixes (HPAM). She focuses on the investigation of the use of Nanomaterials in asphalt mixes as a solution for self-healing and mitigation of fatigue and low temperature cracking. Haya is a recipient of the Ministry of Public Works in Kuwait Scholarship and her research is supported by the Discovery Grant funding program of the Natural Sciences and Engineering Research Council of Canada.

Meet Taha Younes

Taha Younes is a Ph.D candidate in the Civil and Environmental Engineering Department of the University of Waterloo, under the supervision of Professor Susan Tighe.

Taha received his B.Sc degree from Al-Mergab University, Libya in 2009. He received his M.Sc. degree in structural engineering from the University of Waterloo in 2015. During his master's study he has conducted some research in investigation of fatigue behaviour of basalt fibers reinforced polymer (BFRP) materials for prestressed and non-pre-stressed concrete beams.

He then joined the CPATT team in the summer of 2016 and is working on finalizing his PhD research.

Contact Us

Numbers and Email:

Dr. Susan Tighe, Director
519-888-4567 ext. 33152
sltighe@uwaterloo.ca

Dr. Hassan Baaj, Associate Director
519-888-4494
hassan.baaj@uwaterloo.ca

Address:
University of Waterloo
200 University Ave W.
Waterloo, ON N2L 3G1

Jessica Rossi - Office
519-888-4567 ext. 32289
jessica.rossi@uwaterloo.ca

CPATT - Laboratory
519-88-4567 ext. 37731

Thank you to all our CPATT and Norman W. McLeod Chair Sponsors!