CPATT NEWS

Message from the Director

Greetings to all of you! We hope your projects have been successful to date and as you gear up for construction season, that you can continue to have success.

The past few months have been very busy at CPATT. There are multiple projects on-going in the laboratory. In addition, we are working with various agencies to improve pavement and asset management systems. We have just received a new project to evaluate key performance indicators and potentially propose new indicators for the largest management system at a DOT in Canada. This will be a very interesting project. This newsletter focuses on many of the new and existing projects.

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 or Susan Tighe at sltighe@uwaterloo.ca. We look forward to hearing from you!

Sincerely,

Susan L. Tighe, PhD., PEng.

Contents

Feature Faculty Member
Jeff Casello, PhD., P.E.
Associate Professor

Education

Dr. Casello is an Associate Professor, jointly appointed in the School of Planning and the Department of Civil and Environmental Engineering. He came to the University of Waterloo in 2004 after completing his doctoral studies and a Postdoctoral appointment at the University of Pennsylvania. Prior to his Ph.D., Jeff worked as a highway engineer for New York State's Department of Transportation. In that capacity, Jeff developed contract plans for the construction and reconstruction of highways throughout New York. Jeff is a licensed Professional Engineer.

Jeff Casello, PhD., Associate Professor, School of Planning and Department of Civil and Environmental Engineering, University of Waterloo

Research Highlights

Jeff's research focuses primarily on the planning, design and policy necessary to achieve balanced (multimodal) urban transportation systems. More specifically:

- Jeff has published extensively on the planning, design and operation of more efficient – lower cost delivery of service – and effective – greater passenger attraction – public transportation systems.
- He partnered with Professor Vukan R. Vuchic to author the Transit Planning Chapter for the ITE Transportation Planning Handbook 3rd edition in 2009.
- Jeff worked with Metropolitan Knowledge International and McCormack Rankin Corporation to produce the "Economic Impacts of Transit Investment: a National Survey" (2010) which documents the cost savings, health benefits, and economic growth that occurs from transit investments.
- Jeff has conducted groundbreaking research on cycling and cyclists. The research employed GPS units to monitor cyclists' origins and destinations, as well as path choices, such that a calibrated path choice model was developed. The work has led to cycling investment decisions in several municipalities in Ontario.
- He is currently developing and implementing a smart phone application to quantify users' perceptions of transit travel "costs" such that improved mode choice models can be developed.

Professional Activity Highlights

- Jeff has become recognized as a leader in Canadian transit research. He has been invited as the keynote speaker for the Canadian Urban Transit Association and the Ontario Public Transportation Association.
- Jeff and his colleagues have created an international exchange with Karlsruhe, Germany to study best practices in sustainable transport.
- Jeff was invited to Singapore's Land Transport Academy to deliver a short course on transit planning.
- Jeff's former graduate students are now leading transportation professionals, working internationally (the World Bank), for the public sector (Province of Ontario, Region of Waterloo, Town of Ajax) and in consulting (Dillon Consulting, IBI Group, BA Group, other).
- Jeff received the University of Waterloo's Distinguished Teaching Award in 2013.

Research Focus – Perpetual Pavement Satellite Test Sections

CPATT has been involved in a major initiative with the Ministry of Transportation Ontario (MTO) and the Ontario Hot Mix Producers Association (OHMPA) to evaluate the perpetual pavement design philosophy. Two perpetual pavement designs and a conventional control section were constructed in southwestern Ontario on the TransCanada Highway, Highway 401 from 2008-2010. The structural evaluation was executed through the analysis of in-situ tensile strain collected from asphalt strain gauges installed at the bottom of asphalt layers under the wheel path. In addition, asphalt material laboratory characterization was undertaken by testing asphalt samples collected during construction of the three test sections. The laboratory testing was performed at the Centre for Pavement and Transportation Technology (CPATT) at the University of Waterloo. The laboratory experimental matrix in this research included dynamic modulus testing; resilient modulus testing and Thermal Stress Restrained Specimen Testing (TSRST) (see Figure 1). The correlation between various laboratory test results and the collected in-situ tensile strain was evaluated.

Figure 1 – TSRST Test

Several linear regression models were developed to correlate the laboratory test results and the field asphalt temperature with the in-situ tensile strain.

Overall, it was found that the perpetual pavement with the RBM section had the lowest tensile strain at the bottom of the asphalt layers. Figure 2 presents a snapshot for the tensile strain collected from one of the sensors within an 80 minute timeframe. Various models were developed that predict tensile strain at the bottom of asphalt layers by using laboratory test data. The developed models were validated using 30% of the original data. Model validation shows the predicted tensile strain is scattered around the line of balance between predicted and measured strain (see Figure 3). An economic analysis was implemented to evaluate the perpetual and conventional pavement designs including a Life Cycle Cost Analysis (LCCA). Furthermore, a sustainability assessment for both design philosophies was executed to evaluate the environmental benefits of perpetual pavement designs.

The perpetual pavement designs were shown to provide many benefits over the conventional asphalt pavement designs for usage on Canadian Provincial and Interstate Highways in similar climatic zones with similar traffic loading. The advantages of perpetual pavement design philosophy are not limited to structural benefits, but also extended to economic and environmental benefits in the long term.

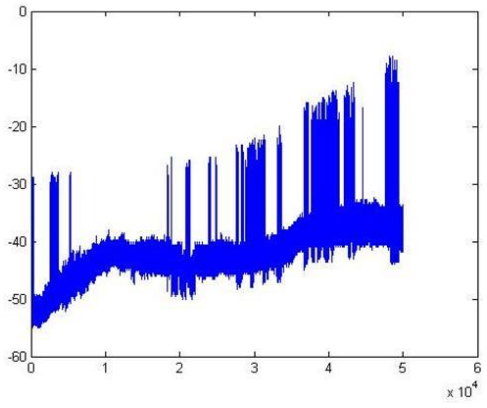


Figure 2. Sample of Tensile Strain Collected in 80 Minutes

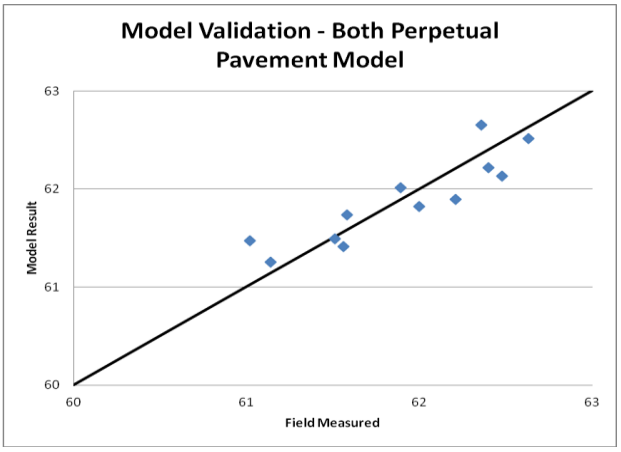


Figure 3. Validation of Perpetual Pavement Structural Modeling

$$Strain = 8.81 - 0.017 \times age - 0.051 \times \frac{1000}{\left(E_0^*\right)^{1/5}} + 0..049 \times \frac{1000}{\left(E_1^*\right)^{0.215}} + 8.79 \times \ln(Temperature) + 0.0096 \times \frac{(TSRST_{Bottom\_Layer})^4}{1000}$$

Research Focus – Highway Asset Management

This research is carried out in partnership with the Ontario Ministry of Transportation. The lead student on this work is Milos Posavljak, who is currently working on his MASc and working as a Project Engineer at the Ministry of Transportation Ontario. The focus is on network level analysis pavement networks. The goal is to develop a unified performance measure for the bridge, pavement, operational, and safety performance of the network; as well as, to provide a process for organizational implementation. The core of the project relies on engineering material knowledge, data analysis, and organizational theory. It is important to avoid introduction of an unfamiliar performance measure to the industry. Subsequently, historical cost data is used in developing a Conceptual Structural Integration Factor (CSIF) – which theoretically converts a bridge deck area into an equivalent pavement section area (EPSA). The bridge performance indicator is scaled to correspond to the agency's pavement performance indicator. A similar approach is planned for operational and safety measures.

The challenge of better material engineering is, and will remain, essential to sustainable infrastructure management. A century of modern roadway construction has yielded an additional challenge: "How to ensure best practices at the material engineering level – maximize societal benefits at the vast network level?" The research looks to address this by providing a means of approaching long-term investment planning such that available funding is optimized while network performance is maximized.

This research would not be possible without the dedication to innovation by the Ontario Ministry of Transportation personnel. A high level of professionalism within all branches of the Provincial Highways Management Division provides a foundation for future progress. Successful management of the Engineering Development Program creates opportunity for young professionals to develop and realize their career aspirations. On page five are photographs of the Highway Infrastructure Business Solutions Project and Central Region personnel. Their contributions are instrumental to the progress of this research.

The pictures on the next page are of colleagues who worked on this project and also a picture on the project. Figure 1 (left to right): Mr. Dante Pangilinan - Transportation investment analyst, Mr. Randy Yu - Structural Area Engineer, Mr. Rob Kohlberger - Geotechnical Engineer, Dr. Li Ningyuan - Senior Pavement Management Engineer. Figure 2: Dr. Laura Kingston – Geomatrics Land Information Coordinator. Figure 3 (left to right): Ms. Sara Child – Sr. Project Manager (I&IT), Mr. John Zajac – Head, Traffic Information, Ms. Sue Lefebvre - Sr. Business Applications Analyst, Mr. Jerry Godin – Principal Project Manager (Highway Infrastructure Business Solutions), Mr. Riaz Ahmed – Investment Planning Engineer, Mr. Dan Remollino – Head, Investment Planning. Figure 4: Mr. Sarath Liyanage – Lead, Information Management. Figure 5 is relating to the actual project.

Research Focus –
Highway Asset Management – Cont'd

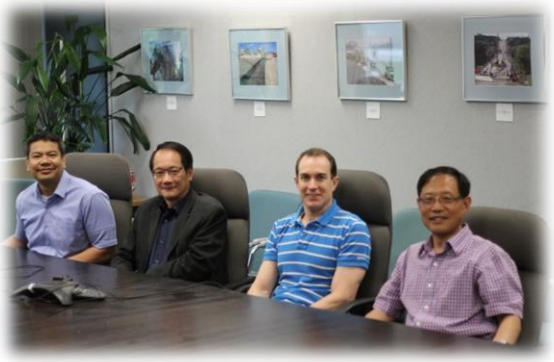


Figure 1

Figure 2

Figure 3

Figure 4

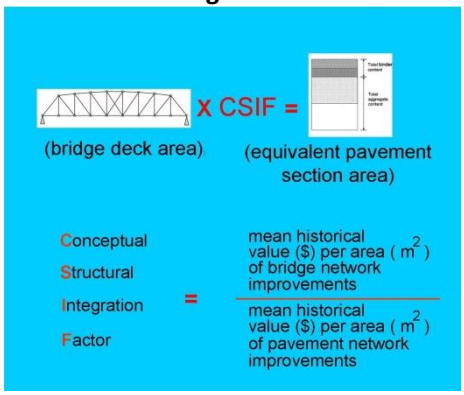


Figure 5

Research Focus – Structures & Concrete Lab

Structures/Concrete Update

Coarse RCA
(note adhered mortar and original aggregate)

Concrete beam-end testing for reinforcement bond in RCA concrete

A UW research project supported by the Cement Association of Canada and NSERC has been investigating the use of recycled concrete aggregates (RCA) in structural concrete applications and pavements.

The experimental program involves aggregate and concrete testing to investigate the relationships between aggregate properties, concrete properties and the bond properties between reinforcing steel and RCA concrete.

Three RCA aggregate sources have been investigated to date, including RCA derived from the crushing of decommissioned building and pavement structures, and from crushing of returned ready-mix concrete. A total of 20 RCA concrete mixtures with compressive strengths ranging from 30 to 60 MPa were developed using RCA to completely replace the coarse aggregate in the concrete. A broad range of physical and mechanical properties were evaluated for the RCA concrete. Reinforcement bond tests were conducted using beam-end specimens.

A variety of relationships between aggregate properties, concrete properties and reinforced concrete bond properties were compiled based on the experiments. These relationships were used to propose an RCA assessment framework for use in structural concrete. RCA performance classes were proposed, each with a specific set of requirements and suitable applications. The performance classes define further requirements and guidance for the use of RCA beyond the provisions of current CSA and ASTM standards. The proposed assessment framework is in the form of a decision tree that allows engineers, concrete producers, aggregate suppliers and contractors to assess whether a particular RCA source is suitable for use in reinforced concrete, plain concrete or as a fill material.

Ongoing research at CPATT is studying other aspects of RCA concrete, and will continue to refine the proposed assessment framework. Contact Dr. Jeff West or Dr. Susan Tighe for further details.

June 2013 Highlights
Feature Student – Marcelo Gonzalez

Marcelo Gonzalez is a PhD candidate working with the Centre for Pavement and Transportation Technology. Born in Talca, Chile, he completed his Master Degree in 2002 from the Pontificia Universidad Catolica de Chile. His expertise is in road engineering, particularly in structural pavement design, evaluation, diagnosis, forensic engineering, pavement rehabilitation and geometric design. He has also worked as a consultant in various countries including: Chile, Argentina, Panama, Paraguay and Peru. He began his PhD. degree at the University of Waterloo in 2012.

Feature Project – Surface Characteristics of Next Generation Concrete Pavements

In partnership with the Cement Association of Canada, CPATT is conducting a research project where the general objective is to increase friction and noise absorption in concrete pavements. Previous research to increase friction and reduce noise production has been focused on creating different surface textures through macrotexture modifications. Due to the key role that microtexture has on pavement, the first innovative stage of this research involves the study of concrete response based on a microtexture modification using nanotechnology, because nanotechnology acts on the concrete microstructure. The second stage of this research will be to create new geometrics on the top of concrete pavement through macrotexture modifications.

The first stage of this research is underway based on a laboratory program where nanosilica and nano lotus leaf are being evaluated, using various tests available at CPATT at the University of Waterloo.

The team working on this project, under the supervision of Susan Tighe, is Marcelo Gonzalez (PhD Student), and Md. Safiuddin (Research Associate, CPATT). It has also involved the participation of five co-op undergraduate students, Jingwen Cao, Yulei Huang, Yinan He, Haolin Zhang, and Arthur Lima and one undergraduate research assistant, Nicola Muzzin.

Here are some pictures from the Surface Characteristics project

Nanosilica sample – particle size between 10 – 20 nanometers

Nano lotus leaf effect on concrete pavement – broom finishing – 0% slope

Laboratory samples for friction with British Pendulum Test and noise absorption with acoustical tube test

Marcelo Gonzalez presenting at the 3rd Advanced Workshop on Innovations and Modeling for Sustainable and Resilient Concrete Pavements, organized by International Society of Cement Pavement (ISCP) in Québec City

June 2013 Highlights
South Frontenac Tour

On June 6, 2013, CPATT hosted 47 maintenance employees from South Frontenac. Susan Tighe gave a presentation on CPATT and then a tour of the pavement laboratory was given. Below are pictures from this event.

June 2013 Highlights
Current & Completed Projects/Laboratory Capabilities

The CPATT laboratory is continuously in use with many projects underway. We thought it would be good to showcase some of the completed projects and also current projects and include some of the equipment being used in the laboratory. Please email Laura Bland for more information on projects or the CPATT laboratory.

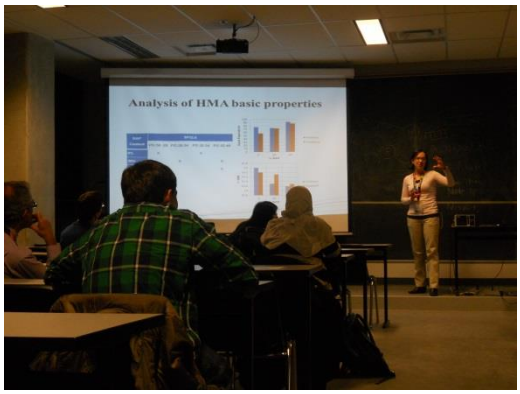
Project	**Start and End Dates**	**Testing and Equipment**	**Research Granting Agency**
Sustainable Long Life Concrete Pavements	2012-2014	Workability (slump), air content and wet density; compressive strength; absorption of acoustical materials using an impedance tube; frictional properties using the British Pendulum Tester; Abrasion resistance of concrete surfaces by the rotating-cutter method; scanning electron microscope (SEM); transmission microscope (TEM); and tribology test	Cement Association of Canada/NSERC
Improving the Fatigue Performance of Hot Mix Asphalt	2012-2014	Flexural Fatigue Test (ITS Fatigue), Dynamic Modulus Test (MTS Dynamic Modulus), Rutting Test (Hamburg Wheel Rut Tester), Cutting Machine – asphalt compactors (Superpave Gyratory compactor – Vibrator (AVC))	Ministry of Transportation Ontario
Determination of Dynamic Modulus for Hot Mix Asphalt required for Mechanistic-Empirical Pavement Design Guide Implementation	2012-2014	Dynamic Modulus Test (MTS Dynamic Modulus), Cutting Machine – Asphalt compactors (Superpave gyratory compactor)	Ministry of Transportation Ontario
Evaluation of Rubber Modified Asphalt: Past, Present, Future	2012-2014	**Tests:** TSRST, Dynamic Modulus and Fatigue Beam **Equipment:** MTS 810 machine, ITS Fatigue Test equipment, Portable Core Drill, and Concrete Cutting Saw	Ontario Tire Stewardship
Determining Quantity of Recycled Asphalt Pavement (RAP) in Hot Mix Asphalt (HMA) Research	2010-2014	**Tests:** TSRST, Dynamic Modulus and Fatigue Beam **Equipment:** MTS 810 machine, ITS Fatigue Test equipment, Portable Core Drill, and Concrete Cutting Saw	Ministry of Transportation Ontario/Ontario Hot Mix Producers Association/NSERC
Development and Evaluation of a Braking Availability Testing Device	2010-2013	**Tests:** BAT Airport Testing at Waterloo Airport **Equipment:** Ford F150 and British Pendulum Tester	Team Eagle Ltd./Ontario Centre of Excellence
Evaluation of Recycled Asphalt Shingles	2009-2012 (completed)	**Tests:** Dynamic Modulus, Resilient Modulus, TSRST and Fatigue Test **Equipment:** Weigh Scale, Oven, Super Gyratory Machine, Resident Pressure Manometer, British Pendulum Tester, MEPDG Software, PaLATE Software	Miller Paving Ltd./Ontario Centre of Excellence

June 2013 Highlights – Engineering Research Symposium 2013

The first annual Engineering Graduate Student Research Symposium was in March 2013 and provided a venue for graduate students to share and showcase their research while honing their presentation skills. The breadth of world class engineering research which is conducted at the University of Waterloo was presented. CPATT had five students present at this event and Andrew Northmore, MASc Candidate won for best presentation. Some pictures from the symposium are below:

Doubra Ambaiowei, PhD Candidate presenting his research

Marcelo Gonzalez, PhD Candidate presenting his research



Xiomara Sanchez, PhD. Candidate presenting her research

Milos Posavljak, MASc Candidate presenting his research

Andrew Northmore, MASc Candidate, presenting his research

Doubra Ambaiowei, Phd Candidate, presenting his research on the 2nd day of the symposium

Undergraduate Program

The UW Department of Civil and Environmental Engineering (CEE) offers three undergraduate programs: Civil Engineering, Environmental Engineering, and Geological Engineering. The total undergraduate enrolment is approximately 800 students, with Civil Engineering comprising more than half. The CEE Department is currently conducting a comprehensive review and renewal of the curriculum and course content for all three programs. The impetus for this review is to adapt the curricula to provide the graduate attributes for engineers of 2020 and beyond, to adapt to the changing learning styles of incoming students, and to align with the new Canadian Engineering Accreditation Board (CEAB) outcomes-based assessment criteria required as of 2014. Increased emphasis will be placed on the social, economical, environmental and energy-related aspects of constructing, operating and maintaining our civil infrastructure. Other key elements include further attention to risk analysis, whole-life costs, construction technology, sensors and monitoring, data collection and analysis, as well as problem solving, team work and communication skills. Emphasis will be placed on outcomes-based, experiential learning and teaching styles, while maintaining the existing high standard of core engineering curricula. The review and resulting changes are intended to attract the best students and enhance the overall student undergraduate experience.

Upcoming Events

June – November 2013 – Ontario Good Roads Association Academy for Municipal Asset Management 2013 Courses. The upcoming courses being offered are Asset Management in Public Buildings (Tarek Hegazy, UW), Asset Management of Road Networks (Susan Tighe, UW), Data Collection and Condition Evaluation (Susan Tighe, UW), and Public Sector Finance Fundamentals. They will be offered as notes below: Please contact Colette Caruso at colette@ogra.org or 289-291-6472 ext. 30 for more information and registration.

- Asset Management of Public Buildings – June 24-28, 2013 – Holiday Inn Airport West, Mississauga
- Asset Management of Road Networks – October 21-25, 2013 – Holiday Inn Airport West, Mississauga
- Data Collection & Condition Evaluation – Oct 28-Nov 1, 2013 – Holiday Inn Airport West, Mississauga
- Public Sector Finance Fundamentals – November 4-8, 2-13 – Holiday Inn Airport West, Mississauga

September 9-12, 2013 – Summer Winter Integrated Field Technologies (SWIFT) 2012 Conference and Trade Show. This conference is being held at The Westin Ottawa, Ottawa, Ontario.

September 22-25, 2013 – 2013 Transportation Association of Canada (TAC) Conference and Exhibition. This conference is being held at the Winnipeg Conference Centre in Winnipeg, Manitoba.

October 4, 2013 – Graduate Student Poster Symposium. This will be held at the University of Waterloo in the Engineering 5 – Student Design Centre from 12:30 – 3:30pm

November 17-20, 2013 – 58th Annual Canadian Technical Asphalt Association (CTAA) Conference. This conference will be held at the Shertaon Hotel Newfoundland in St. John's, Newfoundland.

Announcements

Congratulations

Congratulations to Mohab El-Hakim and family on the arrival of their baby boy, Noah. Noah was born on Thursday April 25th, 2013 at 2:45pm. He weighed 6lbs. 3oz. We wish Mohab and family all the best! (picture of Noah on the left)

Congratulations to Aleli Osorio and Pancho Banados on the arrival of their baby boy, Simon. He was born at Grand River Hospital on Friday May 24th. We wish Aleli and family all the best! (picture of Simon on the right)

Awards/Recognition

Congratulations to Kamal Joshi, MASc Student (Supervisors: Soo Jeon, HJ Kwon and Susan Tighe) on being one of 15 finalists for the Student Video Competition for the Discovery Ontario Centres of Excellence Program. Below is a link to the video and also a link to the event.

Braking Availability Tester Video

Ontario Centre of Excellence You Tube Channel

Student Completed

Congratulations to the following students on completing their degrees. We wish them success in their new roles at the respective companies.

Mehran Kafi Farashah, MASC., Project Engineer, York Region
Zaid Alyami, MASC., Project Engineer
Richard Korczak, MASc., Project Engineer, Stantec Consulting Ltd.
Mohab El-Hakim, PhD., Pavement Specialist, Stantec Consulting Ltd.
Aleks Kivi, MASc., Project Engineer, Applied Research Associates Inc.

Norman W. McLeod Chair in Sustainable Pavement Engineering

Objective of the Chair

The objective of the Chair is to:

- Provide cutting-edge sustainable pavement engineering research
- Develop sustainable and cost-effective materials, designs, construction and management tools
- Collaborate with government, industry, and academia
- Teach and supervise students
- Disseminate findings through seminars, newsletters, papers and reports.

Outreach 2012/2013

In 2012 and January 2013, The Chair and CPATT hosted a Graduate Student Poster Symposium and five research seminars which included:

- Dr. Hernan de Solminihac Tampier, Minister of Mining, Chile – "Emergency Response Following the 2010 Chilean Earthquake"
- Dr. John Harvey, Professor, Civil and Environmental Engineering, University of California at Davis – "Long Life Asphalt and Concrete Pavement Considering Fast Track Construction"
- Dr. Carlos Videla, Professor, Engineering and Construction Management, Pontificia Universidad Católica de Chile – "Reinforced Concrete Structures: Failures, Causes, and Responsibilities"
- Dr. David Timm, Brasfield & Gorrie Professor, Civil Engineering, Auburn University – "Perpetual Pavement Research at the NCAT Test Track"
- Dr. Vincenzo Gallelli, Associate Professor, Territorial Planning, University of Calabria (Italy) – "Pavement Surface Performance Evolution and WMS\A for Eco-friendly Pavement Solutions: Two Experimental Research Approaches"

Collaboration

Over the next few years, the plan is to continue to develop and expand on external collaboration through outreach. We will also start to initiate research based on the Road Map ideas. We will have active participation in various external meetings, seminars and conferences. This also includes active student participation in these activities. If you are interested in collaborating please do not hesitate to contact Laura Bland or Susan Tighe.

News and Awards

New Projects since February 2013

PI (Collaborators)	Title & Agency	Year
K. Soudki	Affect of Self Consolidating Concrete on Strand Bond in Precast/Prestressed Elements - MTO	2013-2014
L. Fu	Predicting the Demand for Winter Maintenance Under Varying Service Standards and Changing Climate - MTO	2013-2014
K. Soudki	Development and Study of UHPC as a Closure Strip Material in Prefabricated Bridge Application – MTO	2013-2014
S. Walbridge	Assessment and UIT Retrofit of Saw Damaged Top Flanges and Undercut Welds	2013-2014
S. Tighe (Md. Safiuddin)	Development of Acceptance Test Methods Related to Performance and Durability of Pervious Concrete - MTO	2013-2015
S. Tighe	Engineering Criteria and Standards for Key Pavement Performance Indicators Used in Pavement Management - MTO	2013-2014

CPATT Everywhere

Two faculty members, Dr. Scott Walbridge and Dr. Sriram Narasimhan, and Richard Morrison, a technologist in the Civil and Environmental Engineering took a trip in the fall of 2012 to perform some testing. The picture below shows an aluminum pedestrian bridge, which is the longest of its kind in Canada, located in Brossard, Quebec.

CPATT

University of Waterloo
200 University Ave, W
Waterloo, ON N2L 3G1
www.civil.uwaterloo.ca/CPATT/

Numbers and Email:

Md. Safiuddin - CPATT - Laboratory
519-888-4567 ext. 37731
msafiudd@uwaterloo.ca

Laura Bland - Office
519-888-4567 ext. 32289
lbland@uwaterloo.ca

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

Dr. Jeff West, Associate Director
519-888-4567 ext. 33323
jswest@uwaterloo.ca