

Norman W. McLeod Chair in Sustainable Pavement Engineering



6/27/2014

2013/2014 Annual Report

This report provides an update of the activities of the Norman W. McLeod Chair from January 2013 – June 2014 inclusive.

Prepared by:

Professor Susan L. Tighe, PhD., P.Eng
Norman W. McLeod Professor in Sustainable Pavement Engineering
Department of Civil and Environmental Engineering

WATERLOO | ENGINEERING

Norman W. McLeod Chair in Sustainable Pavement Engineering

2013/2014 ANNUAL REPORT

This report is intended to summarize the activity of the Chair from January 2013 to June 2014.

1.0 Scope and Objective of the Chair

The scope of the Chair focuses on emerging and innovative pavement technology, state-of-the-art research infrastructure in areas of design, materials, construction, preservation, safety, and management for tackling specific problems, developing new technologies and training skilled people.

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.

One main objective of the Chair is to provide specialized training needed to meet the challenges of transportation engineering in the 21st century. The research and teaching program is designed to develop future leaders and to advance critical partnerships between universities, government, and the private sector.

The Norman W. McLeod Chair in Sustainable Pavement Engineering is in support of the Centre for Pavement and Transportation Technology (CPATT). CPATT has been at the forefront of exceptional research, training and professional activities. This success is rooted in both the experienced and skilled faculty members, as well as the state-of-the-art facilities such as the John J. Carrick Pavement Laboratory at the University of Waterloo, the CPATT Test Track at Waterloo Region's Waste Management Facility and several satellite test sites located across Canada. All of these facilities support the state-of-the-art research program. The current and future research will continue to advance key research needs but will also provide strategic training for the industrial partners and the broader community at large. Development of national and international partnerships will also facilitate technology transfer.

1.1 Personnel Associated with the Chair Management

- Susan Tighe – Chair
- Laura Bland – Administrative Assistant
- Md. Safiuddin – Research Associate
- Anca Constantinescu – Faculty Financial Officer
- Heidi Mussar – Senior Manager, Graduate Financial Aid and Awards

2.0 Partners

We greatly appreciate the support of our partners in the Norman W. McLeod Chair in Sustainable Pavement Engineering. Our industry partners are key industry stakeholders and are knowledgeable in the areas of research in which the Chair will pursue. The resources and expertise they can provide is extremely beneficial as we move forward on various research initiatives. Below is a list of our partners:

- Canadian Asphalt Industries Ltd.
- Capital Paving Limited
- DBA Engineering Ltd.
- Golder Associates Ltd.
- Holcim Canada Inc.
- LVM-Jegel
- McLeod Endowment
- McAsphalt Industries Limited
- Miller Paving Limited
- Ministry of Transportation Ontario
- Ontario Good Roads Association
- Ontario Hot Mix Producers Association
- Ready Mixed Concrete Association of Ontario
- Roto-Mill Inc.
- Shiloh CanConstruct
- Stantec Consulting Limited
- Steed and Evans Limited



3.0 Outreach

Over the past year we have hosted a Graduate Student Poster Symposium and also 3 seminars.

3.1 Graduate Student Poster Symposium

On Friday October 4, 2013 we held a Graduate Student Poster Symposium in the E5 Student Design Centre. There were a total of 19 student participants, who prepared posters on their current research

projects. Industry members, faculty, staff and students attended this event to learn more about what the students were researching. We appreciate Dr. John Emery for judging the poster and special congratulations went to Marcelo Gonzalez, Amin Hamdi and Andrew Northmore. The Norman W. McLeod Chair donated prizes for the student winners.

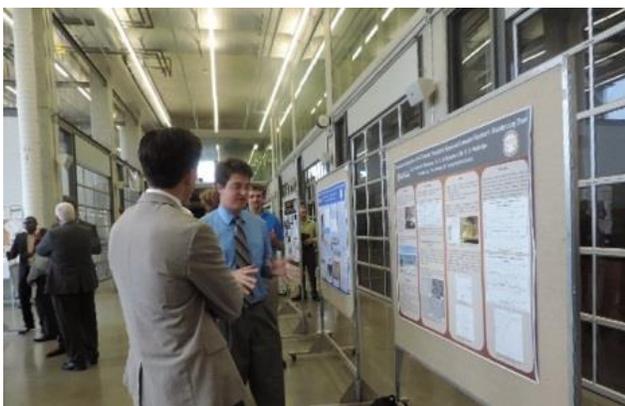
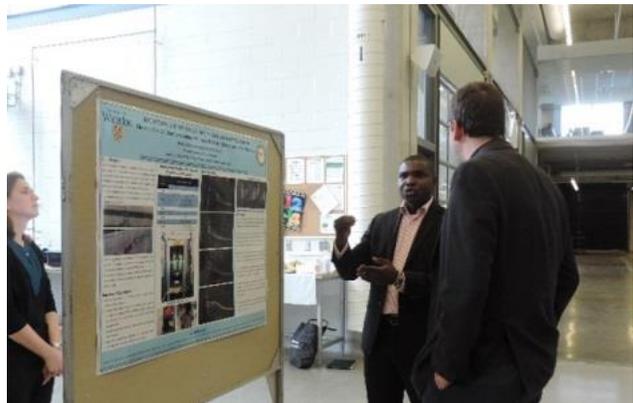
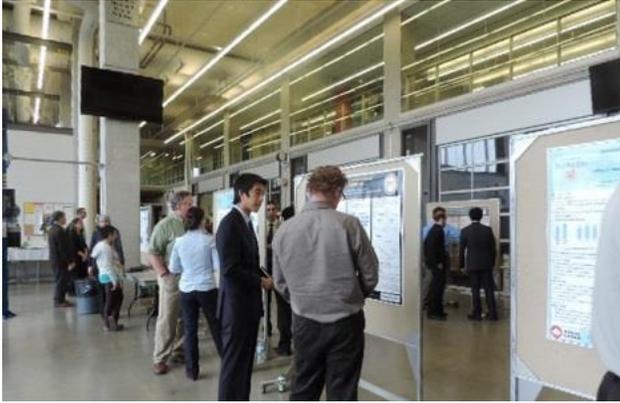
This event was a great way for industry partners to come to the University and ask the students questions and get a better understanding of some of the current research projects. It was also a great opportunity for the students to network with the industry members and receive feedback on their work.

Booklets were provided to the guests, which presented an abstract of each of the student's projects. A list of the projects presented at the 2013 symposium is as follows:

- Doubra C. Ambaiowei, PhD Candidate – Recycling and Testing of Recycled Asphalt Pavements
- Tim Bandura, MASc Candidate – Comparative Evaluation of the Chloride Threshold Values of Corrosion-Resistant Reinforcing Bars
- James Cameron, MASc Candidate – Engineered Fibre-Reinforced Concrete for use in Bridge Deck Link Slabs
- Norman Fong, MASc Candidate – Heat Straightening of Steel Girders
- Marcelo Gonzalez, PhD Candidate – Enhancing the Surface Characteristics of Canadian Concrete Pavements
- Amin Hamdi, PhD Candidate – Evaluation of Ontario's Pavement Design Methodology
- Yu (Tony) Hong, MASc Candidate – Analysis and Design of Link Slabs in Jointless Bridges and Fibre-Reinforced Concrete
- Gulfam Jannat, PhD Candidate – Developing Optimized Pavement (Rigid and Flexible) Maintenance Schedule: Application of Pavement Deterioration Models over the Service Life of Pavements
- Andrew Northmore, MASc Candidate – Sustainability of Solar Road Panels as Transportation Infrastructure
- Dan Pickel, MASc Candidate – Assessing Internal Curing Benefits of Pre-soaked Recycled Concrete Aggregate on Variably Cured Concrete
- Sonia Rahman, MASc Candidate – Development of Acceptance Test Methods Related to Performance and Durability of Pervious Concrete
- Maria-José Rodriguez, PhD Candidate – NDT Condition Assessment of Distribution Lines
- Dina Saad, PhD Candidate – Microeconomic Rationale for Infrastructure Spending
- Xiomara Sanchez, PhD Candidate – Low Temperature Performance of Recycled Hot Mixtures in Ontario
- Magdy Shaheen, PhD Candidate – Predicting Hot Mix Asphalt Rutting using an Innovative Micromechanical Approach
- Ann Sychterz, MASc Candidate – Vibration Characterization and Mitigation of Aluminium Pedestrian Bridges

- Colin van Niejenhuis, MASc Candidate – The Behaviour of Corrosion Resistant Reinforcing Alloys in Cracked Concrete Exposed to Deicing Agents
- Cheng Zhang, MASc Candidate – A Mechanistic-Empirical Aircraft Landing Distance Prediction Method

Some pictures of this event are shown below:



3.2 Seminars

David Timm

On January 9, 2013, the Norman W. McLeod Chair co-hosted a seminar for students on “Perpetual Pavement Research at the NCAT Test Track”. The invited speaker, Dr. David Timm, Brasfield & Gorrie Professor, Civil Engineering, Auburn University, presented on his experience with the National Center for Asphalt Technology Test Track at Auburn University. Dr. David Timm has been at Auburn University since 2011 after completing his doctoral degree at the University of Minnesota where he also received bachelor (1996) and master (1997) degrees. His main research interests are in flexible pavement modeling and structural pavement design. He works extensively with the National Center for Asphalt Technology Pavement Test Track. He teaches senior and graduate level courses in Civil Engineering Materials and Pavement Design. He also teaches various industry short-courses and he is a registered professional engineer in Alabama.

He discussed the fundamental concepts of perpetual pavement design and presented two case studies from the National Center for Asphalt Technology Test Track at Auburn University. Both cases included sections built at the Test Track with embedded instrumentation that provided valuable information regarding pavement response (i.e. stress and strain) and were subjected to extensive falling weight deflectometer testing to characterize the in-situ material properties. The first set of sections were designed and built in 2003 according to the 1993 AASHTO Pavement Design Guide and were not intended to be perpetual. The second set of sections was built in 2006 as part of a perpetual pavement experiment and included a rehabilitation component. Valuable insight into how perpetual pavements function and can be designed and rehabilitated in the future were gained from these sections. The complete presentation can be found at: <https://uwaterloo.ca/centre-pavement-transportation-technology/sites/ca.centre-pavement-transportation-technology/files/uploads/files/TimmWaterloo.pdf>

We greatly appreciated Dr. David Timm taking time to visit the University of Waterloo and present his findings in the area of perpetual pavements. This was especially beneficial to CPATT as we do extensive work at our CPATT Test Track in Waterloo.

Vincenzo Gallelli

On January 28, 2013, the Norman W. McLeod Chair co-hosted a seminar for the students on “Pavement Surface Performance Evolution and WMS\A for Eco-friendly Pavement Solutions: Two Experimental Research Approaches”. The invited speaker, Dr. Vincenzo Gallelli, Associate Professor, Territorial Planning, University of Calabria (Italy), presented on pavement surface performance. Some information about the research presented is below.

Pavement surface texture and skid resistance have a great influence on road functionality and can affect user’s safety, vehicle operational costs, and environmental sustainability. The assessment of the evolution of pavement surface performance plays a fundamental role in road pavement management and is useful in order to achieve adequate allocation of maintenance resources. Furthermore, in recent years, several warm mix asphalt (WMA) technologies have been developed in order to enable significant

energy savings and harmful emissions restraint by reducing mixing and compaction temperatures in hot mix asphalt (HMA) production processes.

In light of the above, two experimental researches were carried out in the Laboratory of Road Materials at the University of Calabria. One of the studies focused on the evaluation of pavement surface performance evaluation by means of a two-year monitoring of an experimental road section. Four different dense graded friction courses were designed with aggregates of different petrographic nature: limestone, basalt and expanded clay. Several surface performances were measured by means of different devices. This work is part of a wider research project designed and in partnership with the Road Network Division of Provincial Administration of Cosenze (Italy), with the final aim of conducting a technical and economic study of the definition of the allowance thresholds in the road management and maintenance contracts.

The second study is a laboratory investigation of compaction characteristics of WMA produced by water-containing methodology with the addition of synthetic zeolites. The influence of the time elapsed between mixing and compaction operations on mixes compactibility was also evaluated in order to define the optimum “Micro-Foaming Time” (FT), in which the additive can completely release the water contained. A systematic comparison between traditional HMA and warm mixes produced at lower mixing/compaction temperatures was carried out: two compaction methods (impact/gyratory) were used. Data obtained from the experimental tests showed that the foaming process due to the addition of the zeolite has a peak value of intensity when the mix is compacted after 1 hour of FT; the effect seems to vanish for a longer period of time when the behaviour of the warm mix is close to that of the mix compacted at the same lower temperature without the additive. The complete presentation can be found at: https://uwaterloo.ca/centre-pavement-transportation-technology/sites/ca.centre-pavement-transportation-technology/files/uploads/files/Seminar_Gallelli_28Jan.pdf

We greatly appreciated Dr. Vincenzo Gallelli taking the time to visit the University of Waterloo and present his findings in the area of perpetual pavements.

Theuns Henning

On May 15, 2014, the Norman W. McLeod Chair co-hosted a seminar for students on “Understanding Road Network Needs Through Performance Measurement and Monitoring”. The invited speaker, Dr. Theuns Henning, Professor, Civil and Environmental Engineering, The University of Auckland, New Zealand, presented on his experience with infrastructure asset management. Dr. Henning received his ME (Transportation) from the University of Pretoria, South Africa, his PhD at the University of Auckland, where he held a Foundation for Research Science and Technology Bridge Future Scholarship. He has worked on many projects with various agencies including the World Bank. His research includes condition deterioration modelling, asset management systems and optimization of infrastructure renewal and replacement programs including road pavements, water pipes and bridges. He is a leading expert on how asset management can be used to manage long term performance contracts. Some information about his research is presented below:

Since ancient Egyptian times, the engineering sophistication of any man-made creation has been directly related to the ability of society to monitor and quantify units of measure. One can only marvel at the

unsophisticated yet extremely accurate measurements that made the construction of the pyramids a reality. Likewise, the importance of accurate measurement and reporting of network status is an integral part of today's modern asset management plans. Performance reporting not only gives an agency the planning context of past performance as a function of historical investment; it also quantifies users' expectations of the Level of Service for a network.

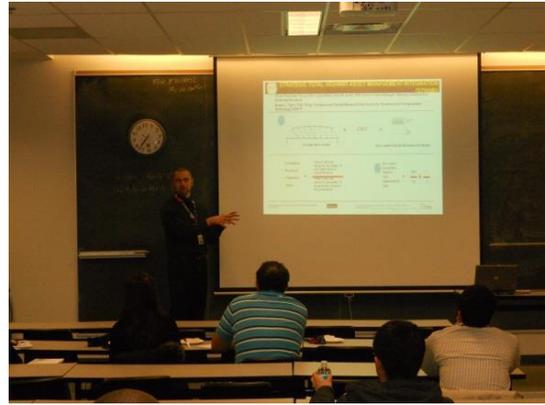
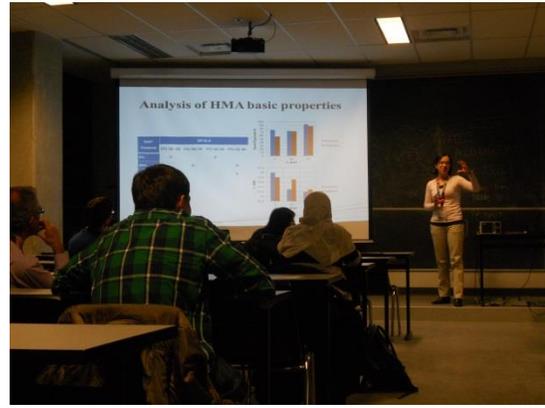
This presentation will summarize valuable lessons from a number of performance management research and implementation projects completed in New Zealand and Canada. The presentation will cover the important business positioning of Performance Management as part of the overall asset management process. It will look at the techniques of aligning performance management frameworks to corporate objectives that have been defined by an agency and, lastly, it will assess performance measures as the means of conveying the performance message in the asset management plan itself. The complete presentation and video can be found here: <https://uwaterloo.ca/centre-pavement-transportation-technology/related-links>

We greatly appreciated Dr. Theuns Henning taking the time to visit the University of Waterloo and present his findings in the area of asset management.

3.3 Engineering Research Symposium

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. Five students under the supervision of Susan Tighe presented their research at this event and Andrew Northmore, MASc Candidate from the group won for the best presentation for the event which included several graduate students from various departments. Some pictures of this event are below:





3.4 Tours and Other Outreach Events

June 2013 South Frontenac Tour

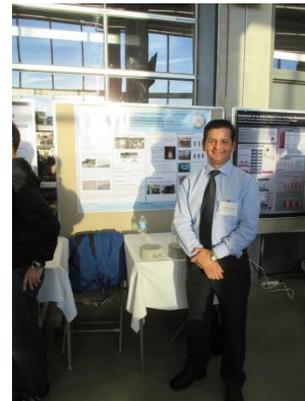
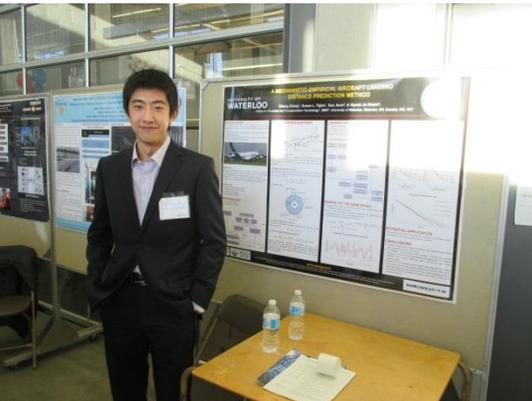
On June 6, 2013, CPATT and the Chair hosted 47 maintenance employees from South Frontenac. Susan Tighe gave a presentation and then a tour of the pavement laboratory was given. Below are some pictures from this event:

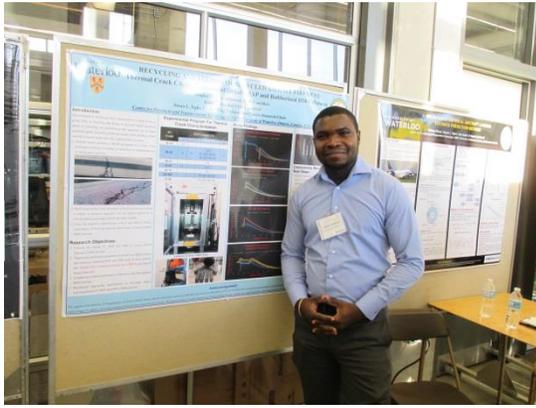




WE Innovate

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. A few of the student from CPATT participated in this event and Marcelo Gonzalez won the award for top 3 best projects. Some pictures of this event are below:





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. The students had 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. Some pictures of this visit are below:





5.0 Recent Projects

Below is a list of some of the recent research projects which relate to the Chair, which Susan Tighe is the principal investigator:

Title	Agency	Year	Status
Performance Evaluation of Coloured Asphalt Pavements and Surface Treatments for BRT Lanes in York Region	York Region - Metrolinx	2014-2016	In-progress
Effect of Warm Mix Additives on Tensile Strength of Compacted Asphalt Mix	Ministry of Transportation Ontario	2014-2016	In-progress
Improvement Strategies for Upstream Heavy Oil Mining Roadways	Imperial oil	2014-2015	In-progress
Engineering Criteria and Standards for Key Performance Indicators Used in Pavement Management	Ministry of Transportation Ontario	2013-2014	In-progress
Soil Stabilization and Solidification	Green Soils Inc. and Holcim Canada Inc.	2013-2015	In-progress
Development of Acceptance Test Methods Related to Performance and Durability of Pervious Concrete	Ministry of Transportation Ontario	2013-2015	In-progress
Sustainable long life concrete pavements	Natural Sciences and Engineering Research Council of Canada	2012-2016	In-progress
	Cement Association of Canada	2012-2016	In-progress

Improving the fatigue performance of hot mix asphalt	Ministry of Transportation Ontario	2012-2014	In-progress
Determination of dynamic modulus for hot mix asphalt required for mechanistic-empirical pavement design guide implementation	Ministry of Transportation Ontario	2012-2014	In-progress
Evaluation of rubber modified asphalt: past, present, future	Ontario Tire Stewardship	2012-2014	In-progress
	Natural Sciences and Engineering Research Council of Canada	2013-2014	Applied
Determining quantity of recycled asphalt pavement in hot mix asphalt research	Ministry of Transportation Ontario	2011-2014	In-progress
	Ontario Hot Mix Producers Association	2011-2014	In-progress
	Natural Sciences and Engineering Research Council of Canada	2012-2014	In-progress
Development and Evaluation of a Braking Availability Testing Device	Team Eagle Ltd.	2010-2013	Completed
	Ontario Centres of Excellence	2010-2013	Completed

6.0 Advisory Board Meetings

The third Advisory Board Meeting scheduled for September 20, 2013 was postponed by Susan Tighe and Dave Leckie (Chair of the Advisory Board) as there were no pressing issues at that time and given the process to hire a new professor was starting in September, it would be best to postpone to meeting to a future date.

7.0 Funding

7.1 Return on Investment

The initial investment in the Chair has been heavily leveraged by the ability to attract high quality students. Since the inception, four full government scholarship students have joined the group. In addition, all industrial funds on research projects have been matched 2:1.

7.2 Total Effective Financial Resources

Initial investment of \$1,500,000 has resulted in approximately \$1,200,000 research funds and \$300,000 funding towards students. Some of this funding for students comes from research projects but also funding comes from scholarships and assistance as described below. In addition, it has enabled for two open houses where more than 500 people have participated. Also six seminars have been hosted where in total of approximately 150 people have attended. The Chair program is also fully utilizing the original \$10 Million CPATT laboratory. This was originally funded by the federal and provincial governments

(Canadian Foundation for Innovation (CFI), the Ontario Innovation Trust (OIT) and Ontario Research and Development Challenge Fund (ORDCF)).

Faculty and Personnel Salary

The salaries for faculty and personnel are approximately \$300,000/per year. These salaries include: Susan Tighe, Laura Bland (Administrative Assistant), Md. Safiuddin (Research Associate), part salary to support Chair for Anca Constantinescu (Faculty Financial Officer), and part salary to support the Chair for Heidi Mussar (Assistant Director, Graduate Financial Aid & Awards). These salaries are provided by the Canada Research Chair program and the University Operating Budget with the exception of Laura Bland and Md. Safiuddin, whose salaries are from Research Funds.

Student Salary Assistance

Total annual funding from student assistance programs is approximately \$120,000/year. The following is a list of the student assistant programs that are included in this amount.

- NSERC USRA
- Ontario Graduate Scholarships
- President's Graduate Scholarships
- Dean's Incentive Program
- Saudi Arabian Scholarship Funds
- Transportation Association of Canada Scholarships
- Canadian Technical Asphalt Association Scholarships
- Queen Elizabeth Scholarships
- Scholarship of Ministry of Higher Education and Scientific Research/Scholarship & Cultural Relations Directorate – Republic of Iraq
- Becas-Chile Scholarship – Chilean National Scholarship Program for Graduate Students
- Part-time students – part-time students salaries are covered by industry

Awards

- 2013 – Aleks Kivi (MAsc Student) – Transportation Association of Canada Best Paper Award
- 2013 – Susan Tighe – Ontario Hot Mix Producers Association Inaugural Bleeds Black Award for commitment to the industry.

Industry Hosted Events

- Participation in Ontario Good Roads Association Municipal Academy
- Ontario Hot Mix Producers Association – Fall 2013 Seminar

Completion of Students

- Andrew Northmore, MAsc., Transportation Specialist, Forensic Engineering Inc.

- Aleks Kivi, MAsc., Project Engineer, Applied Research Associates Inc.
- Mohab El-Hakim, PhD., Pavement Engineer, Stantec Consulting Ltd.
- Milos Posavljak, MAsc., Engineer, Ministry of Transportation Ontario
- Richard Korczak, MAsc., Project Engineer, Stantec Consulting Ltd.
- Jonathon Boone, MAsc., Engineer, Ministry of Transportation Ontario
- Karolina Konarski, MAsc., Pavement Engineer, LVM Inc.
- Dan Pickel, MAsc., Research Assistant, University of Waterloo

Keynote Addresses

- 2013. “Latest RAP Study Research Results”, 2013 Asphalt Seminar Ontario Hot Mix Producers Association, Toronto, December
- 2013. “Innovations in Transportation”, Lion’s Den, Transportation Association of Canada (TAC), Winnipeg, September
- 2013. “Asset Management”, Seminar Series, Coffey International, Australia, April
- 2013. “Pavement Management for Low Volume Roads”, National Seminar, Chile, March

8.0 Future Plans

8.1 New Faculty Position

Interviewing for the new faculty position started in September 2013. After several Skype interviews, three candidates were invited to campus for full day interviews which also included a research and teaching seminar. We will be very pleased to announce the successful applicant, Dr. Hassan Baaj, P.Eng. He will start in September 2014.

Hassan Baaj received a Bachelor degree in Civil Engineering (Geotechnical) in 1994 from the University of Damascus in Syria and worked as a design engineer on geotechnical projects before embarking on scientific research. He then started his Masters and PhD research in France. In 2002, he obtained a Doctorate from the Institut National des Sciences Appliquées in Lyon (INSA Lyon) with Honors Distinction. Hassan’s PhD thesis focused on the fatigue behaviour of asphalt mixtures and was funded by the oil company TOTAL in partnership with the prestigious Laboratoire Central des Ponts et Chaussées in France (ex. LCPC). The National Sciences and Engineering Research Council (NSERC) then awarded him a postdoctoral fellowship at the Institute for Research in Construction at the National Research Council in Canada. For one year, he contributed to the research activities of a research project on the rehabilitation of utility costs.

Hassan then joined the road construction industry in 2003 with Sintra in Quebec (Colas Canada). During the next five years, he had the opportunity to lead and participate in several innovative projects in the roads industry and was in charge of several collaborations with the Ministry of Transportation Quebec, municipalities, and a number of universities in Canada and abroad. He was also involved in several associations and work groups (CTAA, Bitume Quebec, CERIU, etc.). In 2008, he joined Lafarge in

France and took over the responsibility of the Research and Development (R&D) activities of the company in the area of roads at the Lafarge Research Center (LCR). In this capacity, Dr. Baaj has led several research projects on asphalt and aggregates, concrete pavements and hydraulic road binders. Since July 2013, Hassan has been in charge of the “Infrastructure Solutions” R&D program. He leads a team composed of sixteen researchers working actively to develop innovative construction material solutions for infrastructure projects. Hassan holds three patents in the area of construction materials and sustainability.

In addition to his industrial experience, Hassan has kept strong links with academia. He co-authored more than twenty scientific articles published in scientific and technical journals and international conferences, in addition to more than fifty industrial scientific and technical reports. He has supervised the research of several undergraduate and graduate students in France and Canada. He is also an experienced educator who has taught several undergraduate and graduate courses at three universities (Concordia University and Ecole de Technologie Superieure in Montreal, QC, and Ecole Nationale des Travaux Publics de l’Etat in France). He also organized several industrial training sessions for engineers and roads professionals in several countries (Canada, France, USA, Philippines, Zambia, Romania, Poland, and Qatar).

Hassan’s main research interests include: characterization and modelling of the behaviour of construction materials (aggregates, cement, concrete, bitumen, and asphalt mixes); flexible and rigid pavement engineering and design; optimization of the use of recycled materials in sustainable infrastructure systems; sustainable development and environmentally friendly solutions for road construction; and influence of the characteristics of the aggregates on the durability of pavements.

He is excited to be joining the team and will work closely with Susan Tighe.

8.2 Upcoming Seminars

We again plan to host two to three seminars per year. These have yet to be scheduled but we will be sure to keep the Board posted on all seminars so that they can fully participate in the activities.

8.3 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 conference. This also includes active student participation in these activities.