UNIVERSITY OF WATERLOO

MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter
Secretariat

Hassan Baaj
Director, Centre for Pavement Advancement and Transportation Technology (CPATT)

Bernard Duncker
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean
Vice-President, Research and International

DATE: Thursday October 29, 2020

SUBJECT: Support for the Centre for Pavement Advancement and Transportation Technology

- For information -

I am pleased to inform you that, following a presentation from Hassan Baaj, Director of the Engineering-based Centre for Pavement Advancement and Transportation Technology (CPATT), at the Research Leaders Council meeting of September 30, 2020, and a follow-up discussion of October 28, 2020, and based on discussions and recommendations of Research Leaders Council, I recommend that Senate Graduate and Research Council support the renewal of Centre for Pavement Advancement and Transportation Technology (CPATT) for another five-year term.

CENTRE FOR PAVEMENT AND TRANSPORTATION TECHNOLOGY

Waterloo, September 11, 2020

Senate, University of Waterloo
Research Leaders Council

Subject: Renewal of the Centre for Pavement and Transportation Technology (CPATT)

The Centre for the Pavement and Transportation Technology (CPATT) is pleased to submit the attached report that highlights CPATT's mandate, structure, financials, and activities from 2015 to 2020. These activities were in accordance with the 2015-2020 Vision Plan presented in our renewal package to the Senate in October 2015. Also provided in Appendices are the several letters of support from active full-time and adjunct faculty members who were involved in CPATT's research in the last five years. The Dean of Engineering's letter is also attached to this report.

The report shows that CPATT has met and exceeded its 2015-2020 Vision Plan objectives and is financially self-sustainable with no institutional or external funding thus far. Key highlights of the CPATT activities and achievements include:

1. Over $5.5 million in research grants that has been used to support Ph.D., Master and Undergraduate students training;
2. An additional $6.5 million in expected research grants, in which CPATT is a major partner, is currently under review by the sponsoring agencies.
3. Organized, contributed to and hosted several national and international symposiums and workshops which attracted professionals from industry, municipalities, transportation agencies, academia, associations, and students from across Canada and over 17 countries;
4. Dissemination of research results through 244 publications over the course of past five years, including 100 refereed journal articles;
5. Training of 103 HQP including 34 Ph.D. and 21 Masters as well as 22 PDF and Visiting Scholars, many of whom are currently working as faculty members, professional engineers, managers, and as postdoctoral researchers in Canada and internationally;
6. CPATT is financially self-sustaining without financial support from UW or external operating grants. Thus, CPATT is a full cost recovery Centre;
7. At today's date, CPATT has a positive balance of $15,000. It should be noted that due to the pandemic interruptions, CPATT decided to suspend the annual Research User Fee and use some funds to support HQPs to protect them from the adverse effects of the lockdown and losing some highly experienced personnel. This indicates that the centre is not only self-sustainable but resilient to support the department goals during unexpected impacts.
8. Increased faculty involvement that includes UW engineering departments (CIVIL, MECH), Earth Science, Geography and Environmental Management, and other universities (Ecole de Technologie Supérieure, Manhattan College, Chang'An University, Polytechnico di Torino and others)

9. Active leadership in national and international communities by CPATT members such as Chairing committees at Transportation Association Canada (TAC), recognition of the CPATT director as one of the 15 global experts at the International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM), as well as chairing technical committees at RILEM.
10. CPATT continues to increase education and research activities, utilizing multidisciplinary collaboration within and outside UW; and
11. CPATT has established a strong foundation for continued growth over the next five years.

These accomplishments are the result of efforts from CPATT's dedicated and hardworking staff. The presence of CPATT provides a unique opportunity to bring stakeholders from a wide spectrum together (i.e., academia, government, associations, public and private sectors) which is crucial not only to fostering innovation in the pavement and transportation technology area, but also to maximize the research impact by facilitating implementation of the results of high-quality research conducted at CPATT. The centre also creates a synergy for collaborative research both nationally and internationally, which is well received by the scientific and professional community. The CPATT missions and its brand name help attracting highly talented graduate students, researchers, and scholars to UW which reinforces all of the three main themes of the University's strategic plan for 2020-2025: i.e., 1) Developing talent for a complex future, 2) Advancing research for global impact, and 3) Strengthening Waterloo's diverse communities.

CPATT is requesting renewal until 2025 (five years) so we can continue to expand our research, professional education, and training of highly qualified personnel in the area of pavement and transportation engineering and sustain our reputation as one of the leading research centres in the field of pavement engineering both in Canada and internationally .

Respectfully submitted



Hassan Baaj, PhD, DEA, MBET, PEng.
Professor - Associate Chair for Research
Director - Centre For Pavement and Transportation Technology
Norman W. McLeod Professor in Pavement Materials
Civil and Environmental Engineering, Faculty of Engineering, University of Waterloo

Attachments

- Centre for Pavement and Transportation Technology (CPATT) Activities 2015 to 2020.
- Letter of Support, Dean of Engineering, UW
- Letters of Support from active members of CPATT
- The announcement poster for the GRINCH 2019 Symposium - April 2019
- The announcement poster for Rilem Symposium on High Performance Asphalt Materials - October 2019
- The announcement poster for CPATT's Graduate Students Symposium – October 2016
- *Asphalt Research Fund Delivers Bankable Results*, Asphalt Magazine, Spring 2020
- ~~Example of past BOA Meeting Minutes~~
- Samples of CPATT's newsletters

CENTRE FOR PAVEMENT AND TRANSPORTATION TECHNOLOGY (CPATT) – UNIVERSITY OF WATERLOO

PROGRESS REPORT 2015-2020

Hassan Baaj, Ph.D, P.Eng
Professor, Director of CPATT

Updated Sep. 11th, 2020

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Background

The University of Waterloo's long-term track record of research, education and training in pavement materials, engineering and design and transportation led to the formation in 2002 and senate approval in 2005 of the Centre for Pavement and Transportation Technology, CPATT. This initiative started with a funding package of $9 million from the Canada Foundation for Innovation, CFI, Ontario Innovation Trust, OIT, Ontario Research and Development Challenge Fund, ORDCF and various private and public sector partners. Since the original commitment, funding in excess of $23 million dollars from these sources and other partners has continued and resulted in significant growth in research funds since that time.

CPATT's initiative involves an integrated program of field and laboratory research, with the following key objectives: concentrated focus on emerging and innovative technologies, state-of-the-art research infrastructure, increase in the talent pool of HQP and sustained partnerships. CPATT is at the forefront of exceptional research, training and professional activities and is recognized as the leading research centre in pavement and transportation research in Canada. This success is rooted in both the experienced and highly 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 the Waterloo Region's Waste Management Facility and several satellite test sites located across Canada. CPATT researchers have also advised on various international test sites.

The Mission

CPATT's mission is to accept and meet the extraordinary technical and economic challenges and provide leadership in promoting and encouraging research, education and research activities in the pavement and transportation field. CPATT advances critical partnerships between universities, government, and the private sector. It also helps to nurture future leaders for this industry both in Canada and internationally. In conjunction with CPATT, fundraising for the Norman W. McLeod Endowed Chair initiated in 2008 to further assist with this Mission. One main objective of the Chair is to provide the specialized training needed to meet the challenges of transportation engineering in the 21st century. With the assistance of the Dean of Engineering Development office, over $ 1.5 million dollars was raised for this endowment through the generous contributions of the 15 sponsors. Based on this initiative, Prof. Susan Tighe was named the Senior Chair holder, The Norman W. McLeod Chair in Sustainable Pavement Engineering in January 2011 and with the support of the Civil and Environmental Engineering Chair and Dean of Engineering, Prof. Hassan Baaj was hired September 1, 2014 as the Norman W. McLeod Associate Chair in Pavement Materials is in support of the Centre for Pavement and Transportation Technology (CPATT). This additional capacity has had a substantial impact on productivity of CPATT. Prof. Tighe has recently stepped down from her position as Norman W. McLeod Senior Chair as she resigned from her position as Professor at UW but she will continue to be involved in the research activities of CPATT and the Chair as Adjunct Professor. The process for the appointment of the new Norman W. McLeod Chair is currently in progress.

The Norman W. McLeod Chair in Sustainable Pavement Engineering and the Norman W. McLeod Chair in Pavement Materials involves a partnership with 15 partners interested in sustainable pavement research and education. Many of these partners were original sponsors of CPATT while others are new members. All of the CPATT 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.

It also focuses on facilitating interdisciplinary approaches for research areas by establishing links within and outside the University, and solicit funds by sustaining membership and partnerships as well as by affiliate programs.

The Values

- To maintain a commitment to high quality research that advances theory and contributes to management practice or policy development
- To foster a community that promotes the research and personal development of graduate students and faculty
- To support multidisciplinary and interdisciplinary research
- To facilitate commitment to making research findings and their implications available in formats that targets the needs of different audiences
- To achieve responsiveness to the research needs of partners within the University and local community.

Research Accomplishments

Over the past five years, there have been several research collaborations and accomplishments by several of the key CPATT researchers. Several new collaborations were created and increases in research were noted through increased laboratory activity and publications. Part of these new projects and collaborations resulted from the hiring of Prof. Hassan Baaj who joined CPATT in September 2014. Technology transfer and increased productivity was facilitated through interactions with the Board of Advisors, Graduate Student Poster Symposium, national and international venues, faculty interactions, interactions with research partners and various meetings. It is also notable that CPATT hosted three national and international events in 2019. The following is a list of some of the research projects, publications, oral presentations and other research contributions and achievements between 2015 and 2020. The list includes only the contribution of the two principal researchers, Prof. Baaj and Prof. Tighe, that are fully related to CPATT's activities.

List of research projects (2015-2020)

Granting Agency – Program & Role	Total Cash Amount	Period	Project Title
New Frontiers in Research Fund – Transformation (H. Baaj - CO-PI)	~$6,000,000	2021-2026	3-Dimensional Printing and Robotics for Construction

PI: A. Khajepour, Mech. Eng. **LOI Submitted**			
NSERC Alliance Grant Titan Environmental Containment (S. Tighe – CO-PI) PI – Shunde Yin	$115,384	2020-2023	Evaluation of Geosynthetic Reinforced Pavements by Field and Laboratory Testing Integrated with Thermo-hydro-mechanical Modeling
National Research Council – AI for Logistics (H. Baaj - PI) **Under review**	$249,838	2020-2022	Towards Smart and Sustainable Pavement Structures in Canada
NSERC Alliance Grant Peel Plastics, Steed & Evans and Yellowline (H. Baaj - PI) **Ongoing - Alliance under preparation**	$165,000	2020-2022	Optimization of the use of Recycled Plastic Waste Materials in Asphalt Mixes and Binders
Mitacs Accelerate 3Dimesnional Housing Corp. (H. Baaj - CO-PI)	$494,100	2019-2021	Investigation on 3D Wall Printing: Materials, Patterns, Insulation, and Deposition System.
NSERC CRD Imperial Oil, Steed & Evans and Capital Paving (H. Baaj - PI)	$165,000	2019-2022	Sustainable Asphalt Mixes with High RAP Contents and Rejuvenating Agents: Laboratory Evaluation and Plant Validation
Industry Project Sidewalk Labs (S. Tighe - PI)	$247,910	2019-2021	Developing an Urban Interlocking Concrete Paver
NSERC Research Tools and Instruments Grant (H. Baaj - PI)	$ 130,000	2019	Hydraulic Controller and Environmental Chamber for Characterization of Smart Construction Materials and High-Performance Asphalt Concrete Mixes
Industry Project PSI (S. Tighe - PI)	$99,840	2019-2021	Comparison of Various Pavement Design Methodologies
NTAI (S. Tighe - PI)	$49,979	2019-2020	Evaluation of Climate Change Impacts on Northern Pavement
NSERC CRD Porous Pave (S. Tighe - PI)	$168,400	2019-2021	Developing A New Permeable Pavement Type
Industry Project Porous Pave (S. Tighe - PI)	$84,200	2019-2021	Developing A New Permeable Pavement Type
Industry Project Department of Transportation & Infrastructure Renewal (H. Baaj - PI)	$50,500	2019	Impact of Aggregates Properties on Rutting Performance of Warm Asphalt Mixes
NSERC – CRD Ontario Asphalt Pavement Council (S. Tighe - PI)	$86,956	2018-2021	Evaluation of Asphalt Properties in Plant Produced Asphalt Mixes
NSERC CRD Heat Design Equipment (S. Tighe - PI)	$165,000	2018-2020	Exploring A Premium Asphalt Patching Mixes by Using 100% RAP Recycler

NSERC CRD OAPC (S. Tighe - PI)	$85,000	2018-2020	Evaluation of Asphalt Cement Quality
OAPC (S. Tighe - PI)	$50,000	2018-2020	Evaluation of Asphalt Cement Quality
MTO – HIIFP (S. Tighe - PI)	$110,000	2018-2020	Performance Evaluation of Pre-cast Concrete Panels over Asphalt
MTO – HIIFP (S. Tighe - PI)	$93,500	2018-2020	Evaluation of Testing Variability of Semi-Circular Bend (SCB) and Disc-Shaped Compact Tension (DCT) Fracture Tests
OCE VIP I Alternative Runway (S. Tighe - PI)	$25,000	2018-2019	Development of Alternate Runway Material Test Program
MTO – HIIFP (H. Baaj - PI)	$52,875	2018-2019	Pilot Project of High Modulus Asphalt for use on Ontario's highways
OCE VIP I - NSERC Engage MultiSolv (H. Baaj - PI)	$50,000	2018-2019	Development of Biodegradable Asphalt Release Agents
MTO – HIIFP (S. Tighe - PI)	$23,938	2018-2019	Greenhouse Gas Mitigation in Highway Design, Construction and Maintenance - Jurisdictional Scan
OCE VIP I Acrocy (H. Baaj - PI)	$25,000	2018-2019	Development of High-Performance Asphalt Mixes using Nano-fibres
Industry Project Lafarge Research Centre (H. Baaj - PI)	$10,000	2018	State of the Art Review on full Depth Reclamation with Hydraulic Road Blinders
NSERC Engage Bombardier (S. Tighe - PI)	$22,500	2018	
NSERC CRD Lafarge Canada (H. Baaj - PI)	$165,000	2017-2019	Use of Hydraulic Road Binders for In-Place Soil Stabilization and Full-Depth Reclamation of Low Volume Roads
MTO – HIIFP (S. Tighe - PI)	$82,250	2017–2019	Impact of Additives on the Performance of In-Place Recycled Pavements
NSERC CRD Cement Association of Canada (S. Tighe - PI)	$450,000	2017-2022	Sustainable Long-Life Concrete Pavements
NSERC – CRD Cematrix (S. Tighe - PI)	$304,659	2017-2020	Evaluating Pavement Structural Benefits of Lightweight Cellular Concrete
OCE VIP I Kersol (H. Baaj - PI)	$25,000	2017-2018	Development of New Solvent(s) for Extraction of Asphalt Binder
Greater Toronto Airports Authority (S. Tighe - PI)	$25,000	2017	Examining High Performance Asphalt Mixes
NSERC Discovery Grant (H. Baaj - PI)	$135,000	2016-2021	Innovation in High-Performance Asphalt Mixes (HPAM) to increase the service life of flexible pavements in Canada

Ministry of Transportation Ontario (S. Tighe - PI) PI – Brenda McCabe, UofT	$84,250	2016-2019	Examining Work Zone Throughput to Improve Safety, Workzone Efficiency and Cost Effectiveness
NSERC CRD Imperial Oil, Steed & Evans and Miller Paving (H. Baaj - PI)	$190,000	2016-2018	Experimental Study on Blending of Aged and Virgin Binders in Asphalt Mixtures Incorporating RAP to Improve Mix Performance
MTO – HIIFP (H. Baaj - PI)	$105,000	2016-2018	Development of a New Asphalt Mixture Aging/Conditioning Procedure to be used for Performance Testing of Asphalt Mixtures
Embassy of the Republic of Iraq in Canada (S. Tighe - PI)	$21,000	2016	Academic Bench Fee Program for Funded Graduate Student
NSERC Discovery Grant (S. Tighe - PI)	$170,000	2015-2020	Sustainable Long-Life Pavements
Saudi Arabian Cultural Bureau (S. Tighe - PI)	$50,000	2015-2018	Academic Bench Fee Program for Funded Graduate Student
MTO – HIIFP (S. Tighe - PI)	$110,000	2015-2017	Performance Evaluation of Pre-cast Concrete Panels over Asphalt
MTO – HIIFP (H. Baaj - PI)	$83,750	2015-2017	Development of High Modulus Asphalt mix design technology for use on Ontario's highways
MTO – HIIFP (S. Tighe – CO PI) PI - Prof. Yuan Ryerson University	$38,550	2015-2017	Local Calibration of the MEPDG Prediction Models
MTO – HIIFP (S. Tighe – CO PI) PI – Prof. H. Baaj	$77,500	2015-2017	Development of High Modulus Asphalt Mix Design Technology in Ontario
MTO – HIIFP (H. Baaj - PI)	$75,000	2015-2017	Effect of Oxidation Products of Iron Sulphide Minerals in Aggregate on Asphalt Cement
Ontario Centre of Excellence VIP1 & Talent Edge Foamyna Canada (H. Baaj - PI)	$80,000	2015-2016	Optimization of the Use of Recycled Glass-Base Artificial Lightweight Aggregates in the Pavement Structure
MTO – HIIFP (H. Baaj - PI)	$25,000	2015-2016	Effect of Extraction and Recovery Method and Solvent Type on Properties of Recovered Binder
MTO - HIIFP Partnership with Aggregate Recycling Ontario (H. Baaj - PI)	$31,250	2015-2016	Evaluation of Reclaimed Concrete Materials as Aggregate for OPSS Granular B Type II
Industry Project Imperial Oil (S. Tighe - PI)	$75,000	2014-2017	Improvement Strategies for Upstream Heavy Oil Mining Roadways (2 renewals approved)
MTO – HIIFP (S. Tighe - PI)	$80,000	2014-2016	Effect of Warm Mix Additives on Tensile Strength of Compacted Asphalt Mix

York Region (S. Tighe - PI)	$100,000	2014-2016	Performance Evaluation of Coloured Asphalt Pavements and Surface Treatments for BRT Lanes in York Region
NSERC – CRD McAsphalt Industries Ltd. (S. Tighe - PI)	$153,308	2013-2015	Comparing Cold In-place Recycling (CIR) and Cold In-place Recycling with Expanded Asphalt Mixture (CIREAM)
MTO – HIIFP (S. Tighe - PI)	$70,200	2013-2015	Development of Acceptance Test Methods Related to Performance and Durability of Pervious Concrete
NSERC CRD Cement Association of Canada (S. Tighe - PI)	$500,000	2012-2016	Sustainable Long-Life Concrete Pavements

Refereed Journal Papers

J1. S. Raschia, T. M. Baghaee**, D. Perraton, H. Baaj, A. Carter, A. Graziani, "Effect of RAP source on compactability and behaviour of cold recycled mixtures in the small strain domain", Revision submitted to Journal of Materials in Civil Engineering, Submission ID: MTENG-10934R1, Resubmission Date: July 13, 2020.

J2. S. Wang*, H. Baaj, "Impact of Supplementary Cementitious Materials on the Hydration and Strength Properties of Hydraulic Road Binders", Road Materials and Pavement Design, Submission ID: RMPD-20-04-20, Submission date: April 20th, 2020.

J3. A. Hamid*, H. Alfaidi*, H. Baaj, M. El-Hakim, "Effects of Geopolymer on Rheological and Microstructural Properties of Asphalt Binder", Advances in Materials Science and Engineering Journal, Special Issue: Novel Bituminous Materials for Sustainable Pavements, Vol. 2020, 11p.

J4. H. Kadhim*, H. Baaj, "Evaluating the Performance of the Asphalt Mixes Containing Reclaimed Asphalt Pavement by Considering the Effect of Silo Storage Time", Journal of Testing and Evaluation 48, no. 1 (2020): 18-34. https://doi.org/10.1520/JTE20180957

J5. S. Saliani*, A. Carter, H. Baaj, P. Tavassoti**, "Characterization of Asphalt Mixtures Produced with Coarse and Fine Recycled Asphalt Particles", Journal of Infrastructures 4 (67), 2019

J6. E. Melese*, H. Baaj, S. L. Tighe, S. Zupko, and T. Smith. "Characterisation of Full-Depth Reclaimed Pavement Materials Treated with Hydraulic Road Binders." Construction & Building Materials, Volume 226, 30 November 2019, Pages 778-792

J7. S. Wang*, H Baaj. "Treatment of weak subgrade materials with cement and hydraulic road binder (HRB)." Road Materials and Pavement Design (2020): 1-24

J8. S. Saliani*, A. Carter, H. Baaj, P. Mikhailenko, "Characterization of Recovered Bitumen from Coarse and Fine Reclaimed Asphalt Pavement Particles", Infrastructures 2019, 4(2), 24

J9. D. Wang, A. Cannone Falchetto, C. Riccardi, L. Poulikakos, B. Hofko, L. Porot, M. Wistuba, H. Baaj, P. Mikhailenko, K. Hoon Moon, "Investigation on the combined effect of aging temperatures and cooling medium on rheological properties of asphalt binder based on DSR and BBR", Road Materials and Pavement Design, Vol. 20 (sup1), S409-S433, 2019

J10. Y. Azimi Alamdary*, S. Singh, H. Baaj, "Laboratory simulation of the impact of solar radiation and moisture on long-term age conditioning of asphalt mixes", Road Materials and Pavement Design, Vol. 20 (sup1), S521-S532, 2019

J11. Y. Azimi Alamdary*, S. Singh, H. Baaj, "Effect of aggregates containing iron sulphide on asphalt ageing", Road Materials and Pavement Design, Published online, DOI: 10.1080/14680629.2019.1610477, 2019

J12. P. Mikhailenko**, H. Baaj, "Comparison of Chemical and Microstructural Properties of Virgin and RAP Binders and their SARA Fractions", Energy & Fuels, DOI: 10.1021/acs.energyfuels.8b03414., 2019

J13. P. Mikhailenko**, C. Kou *, H. Baaj, et al., "Comparison of ESEM and physical properties of virgin and laboratory aged asphalt binders", Fuel, Volume 235, Pages 627-638, Elsevier, Jan. 2019

J14. T. M. Baghaee*, H. Baaj, "Rheological Characterization of High-Modulus Asphalt Mix with Modified Asphalt Binders." Construction and Building Materials 193, pp.142–152, 2019

J15. G. Ferrotti, H. Baaj, J. Besamusca, M. Bocci, A. C. Falchetto, J. Grenfell, B. Hofko, L. Porot, L. D. Poulikakos, & Z. You, "Comparison between bitumen aged in laboratory and recovered from HMA and WMA lab mixtures" Materials and Structures, Springer, (2018) 51: 150, https://doi.org/10.1617/s11527-018-1270-4

J16. T. M. Baghaee*, H. Baaj, "The Use of Compressible Packing Model and Modified Asphalt Binders in High-Modulus Asphalt Mix Design." Road Materials and Pavement Design, https://doi.org/10.1080/14680629.2018.1536611, 2018

J17. C. Kou*, A. Kang, P. Xiao, P. Mikhailenko*, H. Baaj, L. Sun, & Z. Wu, "A Source Pollution Control Measure Based on Spatial-Temporal Distribution Characteristic of the Runoff Pollutants at Urban Pavement" Sites. Journal Appl. Sci. 8:1802, DOI: 10.3390/app8101802, 2018

J18. T. M. Baghaee*, H. Baaj, "Application of Compressible Packing Model for Optimization of Asphalt Concrete Mix Design", Construction and Building Materials, Elsevier, Vol. 159, p. 530-539, 2018

J19. H. Baaj, P. Mikhailenko**, H. Almutairi*, H. Di Benedetto, "Recovery of Asphalt Mixture Stiffness During Fatigue Loading Rest Periods", Construction and Building Materials, Volume 158, Pages 591-600, 2018

J20. P. Mikhailenko**, H. Khadim*, H. Baaj, S. L. Tighe "Observation of Asphalt Binder Microstructure with ESEM", Journal of Microscopy, 2017 May 4., doi: 10.1111/jmi.12574., 267(3):347-355, 2017

J21. C. Kou*, Peng Xiao, A. Kang, P. Mikhailenko**, H. Baaj, Z. Wu, "Methods to Evaluate the Aging Grades of Reclaimed Asphalt Binder", Applied Sciences, 7(12), 1209; doi: 10.3390/app7121209, 2017

J22. P. Mikhailenko**, H. Khadim*, H. Baaj, "Observation of Bitumen Microstructure Oxidation and Blending with ESEM", Road Materials and Pavement Design, Taylor & Francis, Vol. 18 (sup 2), p. 216-225, 2017

J23. C. Kou*, P. Xiao, A. Kang, P. Mikhailenko**, H., Baaj, Z. Wu, "Protocol for the Morphology Analysis of SBS Polymer Modified Bitumen Images Obtained by Using Fluorescent Microscopy", International Journal of Pavement Engineering, Volume 20, - Issue 5, p. 585-591, 2019

J24. S. Wang*, Q. Lv, H. Baaj, X. Li, Y. Zhao, "Volume Change Behaviour and Microstructure of Stabilized Loess under Cyclic Freeze-Thaw Conditions", Canadian Journal of Civil Engineering, NRC Research Press, 43(10), p. 865-874, 2016

J25. N. Tapsoba**, H. Baaj, C. Sauzeat, H. Di Benedetto, M. Ech "3D Analysis and Modelling of Thermal Stress Restrained Specimen Tests (TSRST) on Asphalt Mixes with RAP and Shingles", Construction and Building Materials, Elsevier, Vol. 120, p. 393-402, 2016

J26. T. M. Baghaee*, H. Baaj, "The Use of Rejuvenating Agents in Production of Recycled Hot Mix Asphalt: A Systematic Review", Construction and Building Materials, Elsevier, Vol. 114, p. 805-816, 2016

J27. H. Al-Bayati*, P. K. Das**, S. L. Tighe, H. Baaj, "Evaluation of Various Treatment Methods for Enhancing the Physical and Morphological Properties of Coarse Recycled Concrete Aggregate", Construction and Building Materials, Elsevier, Vol. 112, p. 284-298, 2016

J28. J. Tierrie, H. Baaj, P. Darmedru, "Modelling the Relationship between the Shape and Flowing Characteristics of Processed Sands", Construction and Building Materials, Elsevier, Vol. 104, p. 235-246, 2016

J29. D. Pickel*, S. Tighe, H. Baaj, R. Fung and E. Saunderson, "Innovative Design, Traffic Management and Construction of Concrete Overlay Technology: A Canadian Municipal Application", Transportation Research Record, 16-2265, 19pp., 2016

J30. P. K. Das**, H. Baaj, S. Tighe, N. Kringos, N., "Atomic Force Microscopy (AFM) to Investigate Asphalt Binders: A State-of-the-Art Review", Road Materials and Pavement Design, Taylor & Francis, Volume 17- Issue 3, p. 693-718, 2016

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J32. T. M. Baghaee*, M. Soltani, M. R. Karim, H. Baaj, "Optimization of Asphalt and Modifier Contents for Polyethylene Terephthalate Modified Asphalt Mixtures Using Response Surface Methodology", Measurement, Vol. 74, p. 159-169, 2015

J33. T. M. Baghaee*, M. Soltani, M.R. Karim, S. Shamshirband, D. Petkovic, H. Baaj, "Estimation of the Rutting Performance of Polyethylene Terephthalate Modified Asphalt Mixtures by Adaptive Neuro-Fuzzy Methodology", Construction and Building Materials, Elsevier, Vol. 96, p. 550-555, 2015

J34. N. Tapsoba**, C. Sauzeat, H. Di Benedetto, H. Baaj, M. Ech, "Three-Dimensional Analysis of Fatigue Tests on Bituminous Mixtures", Fatigue & Fracture of Engineering Materials & Structures, Wiley Publishing Ltd., Vol. 38, N° 6, p. 730-741, 2015

J35. P. K. Das*, H. Baaj, N. Kringos, S. Tighe "Coupling of Oxidative Ageing and Moisture Damage in Asphalt Mixtures", Road Materials and Pavement Design (RMPD), Taylor & Francis, Vol. 16:sup1, p. 265-279, 2015

J36. S. J. Cooke, V. M. Nguyen, D., Anastakis, S. D. Scott, M. R. Turetsky, A. Amirfazli, A. Hearn, C. E. Milton, L. Loewen, E. E. Smith, D. R. Norris. "Diverse perspectives on interdisciplinarity from Members of the College of the Royal Society of Canada", FACETS 5, no. 1: 138-165, 2020

J37. Y. Liu*, H. Wang, S. Tighe, D. Pickel, Z. You. "Study on impact of variables to pavement preheating operation in HIR by using FEM". Construction and Building Materials, 243, 118304, 2020

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Peer-Reviewed Conference Papers

C1. M. Aurilio* and H. Baaj, "Examining the effects of a Self-Healing Elastomer on the Properties of Bitumen", Accepted for publication at the RILEM International Symposium on Bituminous Materials, December 14-16, Lyon, France, 2020.

C2. T. M. Baghaee**, H. Baaj, "Effects of Aggregate Shape Parameters and Gradation on High-Modulus Asphalt Mix Performance", Accepted for publication at the RILEM International Symposium on Bituminous Materials, December 14-16, Lyon, France, 2020.

C3. R. Aurilio*, M. Aurilio*, H. Baaj. "The Effect of a Chemical Warm Mix Additive on the Self-Healing Capability of Bitumen." Accepted for publication at the RILEM International Symposium on Bituminous Materials, December 14-16, Lyon, France, 2020.

C4. P. Tavassoti**, R. Aurilio*, D. Zhao*, H. Baaj, "Investigating the Nonlinear Behavior of Neat and Modified Binders through Large Amplitude Oscillatory Shear (LAOS) Testing." Accepted for publication at the RILEM International Symposium on Bituminous Materials, December 14-16, Lyon, France, 2020.

C5. P. Tavassoti**, T.H. Ameen, G. Cascante, H. Baaj, "Improving the Predictive Master Curve of Bituminous Mixtures Using Ultrasonic Measurements", Accepted for publication at the RILEM International Symposium on Bituminous Materials, December 14-16, Lyon, France, 2020.

C6. P. Tavassoti**, H. Baaj, "Moisture Damage in Asphalt Concrete Mixtures: State of the Art and Critical Review of the Test Methods", Transportation Association of Canada (TAC) Conference, Soils and Materials Session, Vancouver, B.C., 2020.

C7. M. Aurilio*, P. Mikhailenko**, H. Baaj and L. Polikakos, "Properties of Asphalt Binders with Increasing SBS Polymer Modification", 5th International Symposium on Asphalt Pavement and Environment (APE), Padua, Italy, Sep. 2019

C8. Aurilio, M.*, Qabur, A.*, Mikhailenko**, P., Baaj, H., "Analysis of Double Edge Notched Tension Test and Multiple Stress Creep Recovery Test Ability to Predict HMA Fatigue Performance." 2019 Association of Asphalt Paving Technologists Conference March 3-6, Fort Worth, United States (2019).

C9. A. Hamid*, H. Baaj, M. El-Hakim. "Enhancing Asphalt Cement Properties Using Geopolymer- Based on Fly Ash and Glass Powder." Proceedings and Oral Presentation at the 7th CSCE International Specialty Conference on Engineering Mechanics and Materials, Laval, Montreal, Canada, June 12 - 15, 2019.

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C12. P. Mikhailenko**, H. Baaj, "ESEM Microstructural and Physical Properties of Virgin and Laboratory Aged Bitumen", RILEM 252-CMB Symposium. RILEM Book series, Vol. 20, Springer, Cham. (2019).

C13. E. Melese*, H. Baaj, S. L. Tighe, T. Smith, and S. Zupko. "Mechanical Properties of Full-Depth Reclaimed Pavement Materials Treated with Hydraulic Road Binders." In TRB Annual Meeting Online 2019 & Archived Meeting Content. Washington D.C, 2019.

C14. E. Melese*, H. Baaj, S. L. Tighe, T. Smith, and S. Zupko. "Laboratory Assessment on Effects of Blended Cements on Strength and Durability of Full-Depth Reclaimed Pavement Materials | Tac-Atc.Ca." Saskatoon, Saskatchewan, 2018.

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C21. P. Mikhailenko**, H. Baaj, "Overview of Current Asphalt Binder Extraction and Recovery Practices" Transportation Association of Canada Conference, St. John's, Canada, September 24-27, 2017

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C24. Q. Liu, S. M. Hossain**, H. Baaj, S. L. Tighe, A. Shalaby, "Field Assessment of Three-Dimensional Surface Texture and Frictional Properties of Experimental Canadian Road Pavements", World Conference of Pavement and Asset Management, Baveno, Italy, June 12-16, 2017

C25. P. Mikhailenko**, H. Kadhim*, Y. Azimi Alamdary*, H. Baaj "Observation of asphalt binder microstructure with ESEM", Conference of the Transportation Association of Canada, Toronto, ON. 26-29 September, 2016

C26. H. Al-Bayati*, S. L. Tighe, H. Baaj, "Effect of different treatment methods on the interfacial transition zone microstructure to coarse recycled concrete aggregate", Conference of the Transportation Association of Canada, Toronto, ON. 26-29 September, 2016

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C28. T. M. Baghaee*, S. M. Hossain**, H. Baaj "Adoption of statistical analysis to evaluate the permanent deformation of polyethylene Terephthalate (PET) modified SMA mixtures", Conference of the Transportation Association of Canada, Toronto, ON. 26-29 September, 2016

C29. S. L. Tighe, H. Baaj, "Evaluation of Innovative Recycling Techniques: a Canadian case study", 8th International Conference on Maintenance and Rehabilitation of Pavements (MAIREPAV-8), Singapore 27-29 July 2016

C30. A. Schneider*, H. Baaj, P. Lum, S. Senior, "Field Testing and Evaluation of Reclaimed Materials as Aggregate for OPSS Granular B type II", Conference of the Canadian Society of Civil Engineering, London, ON. 1-4 June, 2016

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C36. F. M. Ni*, A. G. Oyeyi*, S. Averyanov, S. Tighe, B. Dolton, J. Li. "Properties of ultra-low density lightweight cellular concrete containing slag". Transportation Research Board 98th Annual Meeting Transportation Research Board, January, Washington D.C., 2019

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C45. H. K. A. Al-Bayati*, S. Tighe "Influence of Coarse Recycled Concrete Aggregates on the Dynamic Modulus of Asphalt Concrete Mixtures". Transportation Association of Canada (TAC), Saskatoon, Saskatoon, 2018

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C55. H. K. A. Al-Bayati*, S. Tighe, "Evaluating the Effects of Mineral Filler on the Volumetric Properties of HMA Mixtures based on Superpave Mix Design Specifications", CSCE Annual Conference, Fredericton, NB, Canada, 2018

C56. S. Kodippily*, J. Yeaman, T. F. P Henning, S. Tighe, "Effects of variation in moisture and temperature on pavement response". 28th Australian Road Research Board International Conference, Brisbane, Australia. ARRB Group, 2018

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C58. D. Lu*, S. Tighe, W. Xie. "Pavement Risk Assessment for Future Extreme Precipitations under Climate Change." Transportation Research Board (TRB) Annual Meeting, January, Washington D.C., 2018

C59. Z. Alyami*, S. Tighe, "Asset Value Index for Infrastructure Asset Management", Transportation Research Board (TRB) Annual Meeting, January, Washington D.C., 2018

C60. R. Wafa*, S. Tighe, G. Moore, D. Perusin, "Construction and Preliminary Results Of Concrete Overlay In Residental Neighbourhoods - A Hamilton Case Study". Transportation Research Board. Transportation Research Board (TRB) Annual Meeting, January, Washington D.C., 2018

C61. D. Pickel*, S. Tighe, W. Lee, R. Fung. "Highway 400 Precast Concrete Inlay Panel Project: Instrumentation Plan, Installation, and Preliminary Results", Transportation Research Board (TRB) Annual Meeting, January, Washington D.C., 2018

C62. G. Jannat*, S. Tighe, "Investigating Cost-Effective Pavement Maintenance & Rehabilitation Strategies through Life Cycle Cost Analysis (LCCA) by Incorporating Variation in Performance based on Material Types and Traffic Levels for Ontario Highways", Transportation Research Board (TRB) Annual Meeting, January, Washington D.C., 2018

C63. D. Lu*, S. Tighe, W. Xie. "Pavement Fragility Modeling Framework and Build-in Resilience Strategies for Flood Hazard." Transportation Research Board (TRB) Annual Meeting (No. 17-01735), January, Washington D.C., 2017

C64. D. Lu*, S. Tighe, W. Xie. "Impacts of flooding on Asphalt Pavements under Climate Change". Canadian Technical Asphalt Association (CTAA) Annual Conference, November 12-15, Halifax, Canada, 2017

C65. Z. Alyami*, S. Tighe, "A methodological framework for implementation of asset management in PPP projects". Proceedings of the World Conference on Pavement and Asset Management (WCPAM 2017), June 12-16, Baveno, Italy, 2017

C66. Z. Alyami*, D. Mizutani, K. Kaito, S. Tighe. "A dynamic optimal model for pavement asset management and PPP projects". Proceedings of the World Conference on Pavement and Asset Management (WCPAM 2017), June 12-16, Baveno, Italy, 2017

C67. R. S. Wafa*, S. Tighe. "Feasibility of Concrete Overlays as a Rehabilitation Strategy on Municipal Roads – City of Hamilton". Transportation Association of Canada. St.John's: Transportation Association of Canada, 2017

C68. D. Pickel*, S. Tighe, R. Fung, S. Lee, P. Smith, T. Kazmierowski, M. Snyder, "Precast Concrete Inlay Panel Installation Method Evaluation", Transportation Association of Canada Annual Meeting, St. Johns, NFLD, CAN, 2017

C69. D. Pickel*, Q. Liu*, R. Wafa*, S. Tighe, R. Fung, "Field Evaluation of Portland Cement Concrete Pavement Surface Texture and Frictional Properties", Transportation Association of Canada Annual Meeting, St. Johns, NFLD, CAN, 2017

C70. Z. Alyami*, S. Tighe. "Project Asset Management for Pavement Assets under Performance-Based Contracts." In Advances in Public-Private Partnerships, pp. 211-224. Reston, VA: American Society of Civil Engineers, 2017

C71. B. McWade*, M. Navarra, S. Tighe. "Harwood Avenue and Bayly Street (Reg. Rd. 22) A Concrete Pavement Urban Intersection Pilot Project." In TAC: Investing in Transportation: Building Canada's Economy--Conference and Exhibition of the Transportation Association of Canada, 2017

C72. G. Jannat*, S. Varamini, S. Tighe. "Investigation of Performance of Superpave Through Mechanistic-Empirical Approach, Field Evaluated Performance, and Laboratory Test Results: A Case

Study for Ontario Highways (Poster)." In TAC: Investing in Transportation: Building Canada's Economy--Conference and Exhibition of the Transportation Association of Canada, 2017

C73. G. Jannat*, S. Tighe. "Developing Performance Prediction Models Based on Traffic and Materials by Incorporating Mechanistic-Empirical Approach for Ontario Highways." No. 17-06054. Transportation Research Board (TRB) Annual Meeting (No. 17-01735), January, Washington D.C., 2017

C74. X. Sanchez*, T. Somers, M. Sweezie, Paving Engineer Construction Branch. "Investigating the Effect of Warm Mix Additive on the Performance of Asphalt Mixtures." In TAC: Investing in Transportation: Building Canada's Economy--Conference and Exhibition of the Transportation Association of Canada, 2017

C75. G. Jannat*, S. Tighe. "Application of Probabilistic Approach for Predicting Pavement Maintenance Requirement: A Case Study on Ontario Highways." In TAC: Investing in Transportation: Building Canada's Economy--Conference and Exhibition of the Transportation Association of Canada, 2017

C76. S. Kodippily*, J. Yeaman, T. Henning, S. Tighe. "Moisture Sensitivity of Pavement Basecourses using Site Data and Soil 2 Water Characteristic Curves 3.", 2017

C77. Q. Liu*, S. Tighe, A. Shalaby. "Assessment of Airfield Runway Macrotexture and Friction Using Three-Dimensional Laser-Based Measurements". No. 17-01393. Transportation Research Board (TRB) Annual Meeting (No. 17-01735), January, Washington DC., 2017

C78. G. Jannat*, S. Tighe. "Investigation of Pavement Performance Index Through Application of a Seemingly Unrelated Regression Model: Case Study on Highways in Ontario, Canada". No. 17-02534. Transportation Research Board (TRB) Annual Meeting (No. 17-01735), January, Washington D.C., 2017

C79. S. Varamini*, M. Esenwa, S. Tighe, M.K. Farashah, T. Moore. "Mixture Design and Field Experience: Coloured Hot Mix Asphalt on Bus Rapid Transit (BRT) Lanes in Ontario." In Proceedings of the Sixth-Second Annual Conference of the Canadian Technical Asphalt Association (CTAA): Halifax, Nova Scotia, 2017

C80. D. Pickel*, S. Tighe, R. Fung, S. Lee, P. Smith, T. Kazmierowski, M. B. Snyder, "Using Precast Concrete Inlay Panels for Rut Repair on High Volume Flexible Pavements", 11th International Conference on Concrete Pavements (ICCP), San Antonio, TX, USA, 2016

C81. Z. Alyami*, S. Tighe, "Integrating Asset Valuation in Transportation Asset Management", Efficient Transportation - Managing The Maintenance Demand, Transportation Association of Canada (TAC), Toronto, Ontario, September 2016

C82. S. Varamini*, M. Kafi, M. El-Hakim, S. Tighe, "Coloured Asphalt Bus Rapid Transit Lanes in The Regional Municipality of York: Integrating Laboratory Performance Testing into Sustainable Pavement Asset Management", Transportation Association of Canada, Toronto, Ontario, 2016

C83. D. Pickel*, S. Tighe, "Development of Precast Concrete Inlay Panel Rehabilitation Strategy for High Volume Asphalt Highways", 11th International Transportation Speciality Conference at the Canadian Society of Civil Engineers (CSCE), London, ON, 2016

C84. A. Kivi*, S. Tighe, R. Fung, J. Grajek. "Long Term Evaluation of Unbonded Concrete Overlay Technology: A Municipal Case Study," 11th International Conference on Concrete Pavements (ICCP), San Antonio, Texas, August 28 - September 1, 2016

C85. S. Varamini*, S. Tighe, "Coloured Asphalt Bus Rapid Transit Lanes in The Regional Municipality of York: Integrating Laboratory Performance Testing into Sustainable Pavement Asset

Management", 11th International Transportation Speciality Conference at the Canadian Society of Civil Engineers (CSCE), London, ON, 2016

C86. S. Varamini*, S. Tighe, "Mechanistic Evaluation of the Effect of Warm mix Additives on the Strength and Durability of Typical Ontario Superpave Surface Mixtures", Canadian Technical Asphalt Association, Banff, Alberta, 2016

C87. J. Bhavsar, M. El-Hakim*, S. Tighe, "Comparison Between Cold –Place Recycling (CIR) and Cold In-Press Recycling with Expanded Asphalt Mixture", Canadian Technical Asphalt Association, Banff, Alberta, 2016

C88. G. Jannat*, T. Henning, S. Tighe, N. Li, "Future of Management Systems: Innovative Key Performance Indicators and Analysis of Data", Eighth International Conference on Maintenance and Rehabilitation of Pavements, DOI: 10.3850/978-981-11-0449-7-049-cd, 2016

C89. A. Zaid*, S. Tighe, P. Malin, "Transportation Asset Management for Public Private Partnership (PPP) Projects", Transportation Association of Canada (TAC), At Toronto, Ontario, 2016

C90. M. J. Rodriguez-Roblero*, G. Cascante, M. D. Pandey, S. Tighe, "Evaluation of the effect of nanosilica in the frosting resistance of concrete through ultrasound", GeoVancouver, October 2-5., Vancouver, BC., 2016

C91. M. Gonzalez*, S. Tighe, J. F. Munoz, J. Grove, "Recommendations for Quality Control of Nanomaterials and Field Construction of PCC Pavements when Nanomaterials are Incorporated", Presentation at the 95th Transportation Research Board Annual Meetings, Paper No. 16-2956, Jan 10-14, Washington, D.C., 2016

C92. Z. Alyami*, S. Tighe, "Asset Valuation: A Performance Measure for Comprehensive Infrastructure Asset Management", Innovative Work in Infrastructure Management: Best Papers from AISIM, 95th Annual Transportation Research Board Annual Meetings, Jan 10-14, Washington, D.C., 2016

C93. Z. Alyami*, S. Tighe, "A methodology for Integration Asset Valuation in Transportation Asset Management", 11th International Transportation Speciality Conference at the Canadian Society of Civil Engineers CSCE, London, ON, June 1-4, 2016

C94. G. Jannat*, T. Henning, C. Zhang, S. Tighe, N. Li, "Road Section Length Variability in Pavement Management Decision Making for Ontario Highway Systems", 95th Transportation Research Board Annual Meetings, Paper No. 16-5874, Jan 10-14, 2016, Washington, D.C., 2016

C95. S. Varamini*, S. Tighe, "Effect of Colouring Pigment on Asphalt Mixture Performance: Case for Use in Ontario", 95th Transportation Research Board Annual Meetings, Paper No. 16-3889, Jan 10-14, Washington, D.C., 2016

C96. S. Varamini*, S. Tighe, "Canadian Usage and Practices for Evaluating Warm-Mix Asphalt Moisture Susceptibility", 95th Transportation Research Board Annual Meetings, Paper No. 16-3854, Jan 10-14, Washington, D.C., 2016

C97. C. Torres-Machi*, A. Osorio, P. Godoy, A. Chamorro, C. Mourgues, C. Videla, S. Tighe, "Incorporating Sustainability into Pavement Asset Management: Application to an Urban Network", 95th Transportation Research Board Annual Meetings, Paper No. 16-6277, Jan 10-14, Washington, D.C., 2016

C98. G. Jannat*, S. Tighe, "Investigating Life Cycle Cost Analysis to Identify Sustainable Pavement Maintenance and Rehabilitation Strategy: A Case Study on Ontario Highways", Transportation Association of Canada Conference, September 25-28, Toronto, 2016

C99. G. Jannat*, S. Tighe, "Developing new Performance Index for Assessing overall Pavement Condition by Incorporating of Mechanistic-Empirical Approach for Ontario Highways", Transportation Association of Canada Conference, September 25-28, Toronto, 2016

C100. G. Jannat*, S. Tighe, "Developing Engineering Criteria and Standards for Key Performance Indicators (KPI) used in Pavement Management", 8th International Conference on Maintenance and Rehabilitation of Pavement, Singapore, July 27-29, 2016

C101. M. Shaheen*, A. Al-Mayaa, S. Tighe, "Visualization and Quantification of Hot Mix Asphalt Characteristics Using X-Ray Computed Tomography", 60th Annual Conference of the Canadian Technical Asphalt Association (CTAA), Ottawa, ON, 2015

C102. M. Shaheen*, S. Tighe, A. Al-Mayah, "Improvement of Hot Mix Asphalt Surface Course Mix Design for Fatigue Resistance", 60th Annual Conference of the Canadian Technical Asphalt Association (CTAA), Ottawa, ON, 2015

C103. D. Ambaiowei*, S. Tighe, "Rubberized Asphalt Mixtures in RAP: A Case for Use in Ontario", 94th Annual Transportation Research Board Annual Meetings, Paper No. 15-0960 Washington, D.C. Jan 2015

C104. X. Sanchez*, V. Aurilio, S. Tighe, S. Brown, F. Magisano. "Use of the Hirsch Model to Backcalculate the Performance Characteristics of Blended Binder in Superpave Hot Mix Materials", 60th Annual Conference of the Canadian Technical Asphalt Association (CTAA), Ottawa, ON, November 15-18, 2015

C105. L. Uzarowski*, M. Maher, S. Tighe, "Green Pavement Technologies are Sustainable Only if they Deliver Acceptable Performance", 60th Annual Conference of the Canadian Technical Asphalt Association (CTAA), Ottawa, ON, November 15-18, 2015

C106. R. Rizvi*, S. Tighe, L. Uzarowski. "Research to Identify Advanced Asphalt Technology to Address Shear Distresses on Airfield Facilities", Conference of the Transportation Association of Canada, Charlottetown, September 2015

C107. G. Jannat*, S. Tighe, "Performance Based Evaluation of Overall Pavement Condition Indices for Ontario Highway Systems", Conference of the Transportation Association of Canada, Charlottetown, September 2015

C108. A. Ayed*, S. Tighe, "Local Calibration for Mechanistic-Empirical Design using Genetic Algorithm", Conference of the Transportation Association of Canada, Charlottetown, September 2015

C109. S. Tighe, "Vulnerabilities and Design Considerations for Pavement Infrastructure in Light of Climate Change", Conference of the Transportation Association of Canada, Charlottetown, September 2015

C110. S. Tighe, "Braking Availability Testing Device", 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C111. S. Tighe, "Demonstrating how Sustainability Can Effectively be Incorporated in to Pavement Management", 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C112. X. Sanchez*, S. Tighe, V. Aurilio, "Mechanical Response of Superpave Recycled Hot Mixtures in Ontario", Conference of the Transportation Association of Canada/Green Technology in Pavement and Materials Engineering Session, Charlottetown, Canada, September 2015

C113. J. Bhavsar*, S. Tighe, "Performance Evaluation of Cold in Place Recycling (CIR) Mixes for Ontario", Conference of the Transportation Association of Canada, Charlottetown, September 2015

C114. S. Varamini*, S. Tighe, "Survey on Current Practices For Evaluating Warm Asphalt Moisture Sensitivity", Conference of the Transportation Association of Canada, Charlottetown, September 2015

C115. C. Gray, J. Yeaman*, S. Tighe, "Using Innovative In-Situ Measuring Tools To Better Understand Asphalt Performance", Australian Asphalt Pavement Association International Conference, Gold Coast, Australia, September 2015

C116. S. Tighe, J. Yeaman*, "Developing A Framework for Innovative Research and Education Which Improves Pavement Life Cycle and Reduces Costs", Australian Asphalt Pavement Association International Conference, Gold Coast, Australia, September 2015

C117. C. Johnston*, A. Wiegand, S. Tighe, J. Yeaman. "Impacts of Asphalt Laboratory Compaction Techniques: Does it really affect the Master Curve?", Australian Asphalt Pavement Association International Conference, Gold Coast, Australia, September 2015

C118. X. Sanchez*, D. Ambaiowei, S. Tighe, "Low Temperature Performance of Superpave Recycled Hot Mixtures in Ontario", International Airfield and Highway Pavements Conference: Modifications of Warm and Hot Asphalt Concrete and Performance, June 2015

C119. Z. Alyami*, S. Tighe, "Asset Valuation: A Performance Measure for Comprehensive Infrastructure Asset Management", Annual Inter-University Symposium on Infrastructure Management (AISIM), University of Delaware, May 21-22, 2015 (BEST PAPER AWARD)

C120. Z. Alyami*, S. Tighe, D. Gransberg, M. Bianchin, "Performance Measures for Pavement Assets Under Performance Based Contracts", 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C121. Z. Alyami*, S. Tighe, "Pavement Maintenance on Long Term Performance Based Contracts" 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C122. Z. Alyami*, S. Tighe, "Project Asset Management for Pavement Assets under Performance Based Contracts" Proceedings of the 2nd International Conference on Public-Private-Partnerships, Austin, TX, 26-19 May 2015

C123. A. Hamdi, M. El-Hakim*, S. Tighe, N. Li, "Pavement Maintenance on Long Term Performance Based Contracts" 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C124. S. Pinto*, S. Tighe, "Improving Airport Pavement Management Using an Analytical Hierarchy Process Decision Making Tool Braking Availability Testing Device", 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C125. S. Tighe, "Accelerated Testing and Instrumentation: A Canadian Case Study", 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C126. D. MacLeod*, S. Tighe, M. Juhasz, "Pavement Management Systems for Canadian Low Volume Roads", 9th International Conference on Managing Pavement Assets, Washington, D.C., May 18-21, 2015

C127. M. Gonzalez*, S. Tighe. "Nanotechnology Applied in the Design of the Next Generation of Concrete Pavements Surface" Fifth International Symposium on Nanotechnology in Construction (NICOM5), Chicago, IL. May 24-26, 2015

C128. F. Irali, M. Gonzalez*, S. Tighe, A. Simone, "Temperature and Aging Effects on Tire/Pavement Noise Generation in Ontarian Road Pavements", 94th Annual Meeting of the Transportation Research Board, Paper No. 15-3877, January 11-15, 2015

C129. M. Longhi, M. Gonzalez*, S. Rahman, S. Tighe, C. Sangiorgi, "Evaluation of the Strength and Abrasion Resistance of Pervious Concrete Mixes Using Three Types of Cement (GU, GUL, nanocement)", 94th Annual Transportation Research Board Proceedings, Washington, D.C., Paper No. 15-3369, January 11-15, Washington, D.C (presentation), 2015

C130. L. Jiao*, J.Yang, Y. Huang, S. Tighe, "Development of Frost-Thaw Prediction Model on Weather Information", 94th Annual Transportation Research Board Proceedings, Washington, D.C., January 11-15, 2015. Paper 15-2067, Washington, D.C, 2015

C131. M. Gonzalez*, S. Tighe, J. Medley, "Assessing Friction Response of Nanoconcrete for Rigid Pavements Using British Pendulum Tester and Tribometer", 94th Annual Transportation Research Board Proceedings, Paper No. 15-1669, Washington, D.C., January 11-15, Washington, D.C, 2015

C132. A. Osorio, A. Chamorro*, S. Tighe, C. Videla, "Development of Performance Models of Urban Pavements for Network Analysis", 94th Annual Transportation Research Board Proceedings, Washington, D.C., Paper No. 15-0427 January 11-15, Washington, D.C, 2015

C133. A. Chamorro*, S. Tighe, "Optimized Maintenance Standards for Unpaved Road Networks Based on Cost-Effectiveness Analysis", 94th Annual Transportation Research Board Proceedings, Washington, D.C., No.2473. January 11-15, Washington, D.C, 2015

C134. Z. Alyami*, S. Tighe, "Project Asset Management for Performance Based Contracts", Innovative Work in Infrastructure Management: Best Papers from AISIM, 94th Annual Transportation Research Board Proceedings, January 11-15, 2015

Conference Papers with Abstract Selection

C135. M. Aurilio*, P. Tavassoti, M. Elwardany, H. Baaj. "Comparing the Ability of Different Tests and Rheological Indices to Evaluate the Cracking Resistance of Polymer Modified Asphalt Binders." Canadian Technical Asphalt Association Conference, November 9-20, Kelowna, Canada, 2020.

C136. R. Aurilio*, M. Aurilio*, H. Baaj. "High-Performance Pavements: A focus on self-healing asphalt technologies", Canadian Technical Asphalt Association Conference, November 15-18, Kelowna, Canada, 2020.

C137. P. Tavassoti**, H. Baaj, P. Mikhaelinko, L. Eamer, "Experimental Evaluation of Biodegradable Asphalt Release Agents in Canada", 64th Canadian Technical Asphalt Association (CTAA) Conference, Montreal, QC, Canada, 2019.

C138. M. Aurilio*, A. Qabur*, P. Mikhailenko**, H. Baaj. "Comparing the Fatigue Performance of HMA Samples with PMA to their Multiple Stress Creep Recovery and Double Notched Tension Test Properties." Canadian Technical Asphalt Association Conference, November 11-14, Regina, Canada, 2018.

C139. T. M. Baghaee*, H. Baaj. "Development of High-Modulus Asphalt Mix Designs for Ontario's Highways." Canadian Technical Asphalt Association Conference, November 11-14, Regina, Canada, 2018.

C140. H. Kadhim*, H. Baaj. "Evaluation of the Impact of Silo Storage on Thermal Cracking of the Hot Mix Asphalt with RAP." TAC 2018: Innovation and Technology: Evolving Transportation-2018 Conference and Exhibition of the Transportation Association of Canada, 2018.

C141. H. Almutairi*, P. Mikhailenko**, H. Baaj, "Rutting Performance of Asphalt Mixtures with Nanotube-fibers with Varied Addition Rates." Canadian Technical Asphalt Association Conference, November 11-14, Regina, Canada, 2018.

C142. S. Saliani*, A. Carter, H. Baaj, S. Badeli, "Investigation on tensile strength of Hot Mix Asphalt with inclusion of pulp aramid fiber (PAF)", Proceedings of the 62nd Annual Conference of the Canadian Technical Asphalt Association, Halifax, NS, November 15–15, 2017

C143. M. Aurilio, P. Mikhailenko**, H. Baaj, "Predicting HMA Fatigue Using the Double Edge Notched Tension Test and Multiple Stress Creep Recovery Test", Proceedings of the 62nd Annual Conference of the Canadian Technical Asphalt Association, Halifax, NS, November 15–15, 2017

C144. P. K. Das*, N. Kringos, H. Baaj, S. Tighe, "Investigation of diffusion-controlled oxidative aging in asphalt mixture", Proceedings of the 60th Annual Conference of the Canadian Technical Asphalt Association, Ottawa, ON, November 15-18, 2015.

Awards and Recognitions

National/International Awards and Recognitions:

- **Susan Tighe,** Fellow, Engineering Institute of Canada, 2020
- **Hassan Baaj,** Expert, RILEM Association, 2020-2022
- **Hassan Baaj,** Chair, Soils and Materials Standing Committee, Transportation Association of Canada, 2018-2020
- **Susan Tighe,** International Association of Advanced Materials (IAAM) Medal Lecture, Stockholm Sweden, 2019
- **Susan Tighe,** Fellow, Canadian Society for Civil Engineering, 2019
- **Hassan Baaj,** University Research Award, Imperial Oil ($25,000/year for three years), 2019
- **Susan Tighe,** Fellow, Canadian Academy of Engineering, 2018
- **Susan Tighe,** Canada Research Chair, Natural Science and Engineering Research Council, 2005-2015
- **Hassan Baaj,** 2015: University Research Award, Imperial Oil ($25,000/year for three years)

University of Waterloo/Endowed Chair Awards:

- **Hassan Baaj,** University of Waterloo, Outstanding Performance Award (OPA), 2020
- **Hassan Baaj,** Waterloo Engineering Society, Teaching Excellence Award, Fall 2019
- **Susan Tighe,** University of Waterloo, Special Performance Award, awarded for outstanding performance, 2004, 2010, 2014,2018
- **Susan Tighe,** Faculty of Engineering, Graduate Supervision Award, 2016
- **Susan Tighe,** University of Waterloo, Award of Excellence in Graduate Supervision, 2017
- **Hassan Baaj,** UW Faculty of Engineering Distinguished Performance Award, 2017

Provincial/Regional/Industry Awards:

- **Susan Tighe,** Research & Development Medal, 2016 Ontario Professional Engineers Awards (OPEA), 2016
- **Susan Tighe**, 2016 MTO Women in Engineering, Celebrating 100 years of Women in Engineering, 2016

Best Paper/Presentation Awards:

- Hanaa Al-Bayati, **Susan Tighe**, 2019, Best Paper, TAC Conference, Halifax, NS Canada
- Dahlia Malek (MASc Student), Victoria Speller (MASc Student), and **Susan Tighe**, 2018, Best Paper, CSCE 2018 Annual Conference, Fredericton, NB, Canada
- Eskedel Melese (PhD Student), Hassan Baaj, Best Student Paper (paper co-authored with my student), 2018 Transportation Association of Canada Conference, Saskatoon, SK
- Adam Schneider (MASc Student), **Hassan Baaj**, Best Student Paper, Transportation Association of Canada (TAC) Conference, 2016
- Gulfam Jannat, (PhD Student), **Susan Tighe**, Best Poster, Transportation Association of Canada (TAC) Conference, 2016
- Zaid Alyami, (PhD Student), **Susan Tighe**, Annual Inter-University Symposium on Infrastructure Management (AISIM), 2015.
- Mike Aurilio (MASc Student), Peter Mikhailenko (PDF), **Hassan Baaj**, Best Paper Elaine Thompson Award – 62nd Canadian Technical Asphalt Association Conference, Halifax, NS, 2017
- Mike Aurilio (MASc Student), Peter Mikhailenko (PDF), **Hassan Baaj**, Norman McLeod Award for Best Oral Presentation – 62nd Canadian Technical Asphalt Association Conference, Halifax, NS, 2017

Event Organization

In the last five years, CPATT have hosted more than 30 invited talks, seminars and Lunch and Learn events Seminars by experts from across the country and internationally. Either those whom we have invited specifically to give a talk or those who gave a seminar as they were here as external Ph.D. committee members. In 2019, CPATT hosted three important national and international events.

Pavement Engineering Research Symposium: CPATT hosted in April 2019 the annual meeting of the (GRINCH) which is a research group originally created by the pavement engineering researchers at Laval University and the École de Technologie Supérieure is Québec. In 2019, the event has been expanded to become a Pan-Canadian event with the participation of faculty members, researchers and graduate students from eight different Canadian Institutions. The announcement poster for this event is included in the Appendix.

Annual Meeting of Cluster F (Bituminous Materials and Polymers) of the Rilem: Rilem (International Union of Laboratories and Experts in Construction Materials, Systems and Structures) is an internationally recognised organization that brings together researchers working on the development of the construction materials of the future. The cluster F focuses on finding innovative and sustainable solutions to make transportation infrastructure more durable and environmentally friendly. Prof. Baaj leads currently one of the 5 committees of the cluster (TC-278 CHA: Crack Healing of Asphalt). Three other committees work on recycling and energy efficient solutions and the last committee work on understanding the fundamentals of chemical and physical interactions in asphalt materials. The meeting took place on Monday Sep. 30th and Tuesday Oct 1st. Around 50 academic and industrial researchers representing 24 different universities and research institutions in 13 different countries.

Rilem Symposium on High Performance Asphalt Materials: We have invited some of the researchers attending the Cluster F meeting to stay for one day in order to organize an international symposium. The event was sponsored by UW Engineering, CEE and CPATT in addition to several other industrial sponsors. The event was very successful and was attended by more the 100 participants from MTO engineers, municipalities and industry in addition to graduate students and faculty members from UW. The announcement poster for this event in included in the Appendix.

Training of Highly Qualified Personnel

Below is a summary of highly qualified personnel involvement with CPATT since 2015 including current students and others working with CPATT.

Summary of Highly Qualified People Training involved in CPATT (2015-2020)

Status	Undergraduate*	Masters	PhD	PDF, Visiting Scholars
Completed	24	17	17	16
Ongoing	2	4	17	6

*Includes Co-op students, USRA and URA

The productivity of the HQP has been substantial. The goal is that students participate in an active research program where they interact with others. Students within the group lead the majority of publications and these students are highly employable upon completion. The following is a brief summary where some of the former HQP are currently employed:

- Several Assistant Professors (University of New Brunswick, Carlton University, Catholic University of Chile, King Aziz University Saudi Arabia, etc.)
- Post-Doctoral Positions (EMPA Switzerland)
- Several Principal Engineers (Stantec Consulting, Golder Associates, Englobe)
- Several Project Engineers and Managers (Hatch Mott MacDonald, MMM, CH2M Hill, IBI Group, SNC Lavalin, iTRANS, Applied Research Associates, Fugro-Roadware and WSP)
- Several Senior Postings in Government (Ministry of Transportation Ontario, Alberta Transportation, Manitoba Highways, Saskatchewan Highways, York Region, Region of Waterloo, City of Waterloo)
- Associations (World Bank, Ontario Good Roads Association, Ontario Asphalt Pavement Council)

In addition, several visiting professors and scholars have come to CPATT over the past five years. They have visited from Canada, United States, Chile, China, France, Italy, Oman and Germany. Several of these visitors have given seminars to CPATT but these have also been advertised university wide. Typically, there are two to three seminars per year. Attendance at seminars has been excellent and, in several cases, many working professionals have attended.

Governance and Administrative Structure

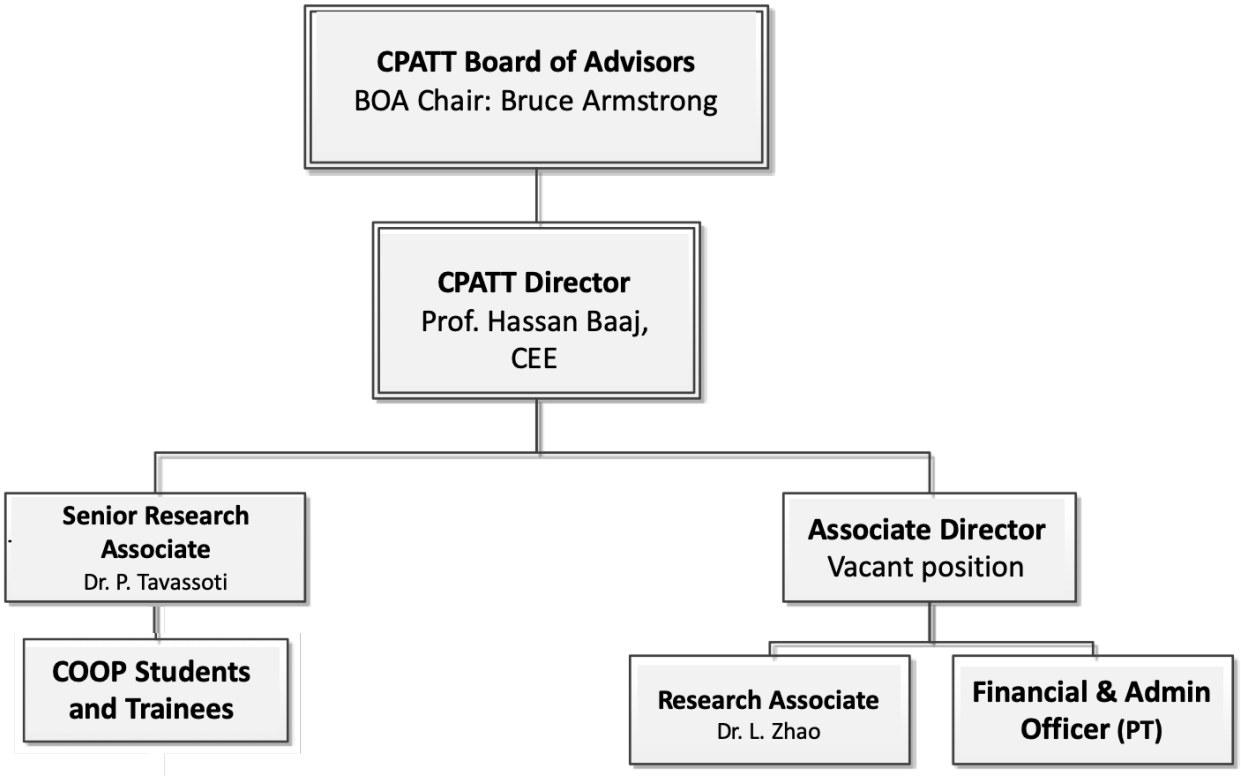
The general organizational structure for CPATT involves a three-way partnership of public sector and private sector agencies and the universities. Overall guidance is provided by a Board of Advisors, with

representation from the major funding partners. The Director and the Associate Director are responsible for the on-going management of the research programs.

Internally the Director, Associate Director and the Senior Research Associate provide leadership of the Research Team. The following members are involved with CPATT activities in an in-depth way:

- Prof. Hassan Baaj, Director (Sep. 2017 – present), Associate Director (2015 – 2017)
- Prof. Susan Tighe, Past Director (past 2015 – Sep. 2017)
- Prof. Shunde Yin, Candidate for the post of Associate Director (Starting Oct. 2020)
- Dr. Pezhouhan Tavassoti-Kheiry, Senior Research Associate
- Dr. Guangyuan Zhao, Research Associate

The following figure is a schematic presentation of the organization of CPATT.



CPATT Board of Advisors (BOA)

The Board of Advisors, as identified earlier, is constituted to represent stakeholders within the University and community. The purpose of the board is to provide strategic direction and it does not have an operational or fiduciary responsibility. The role of the board is to provide input and advice to the director and research theme, champions on research directions, dissemination of results, partnerships and sources of funding. ~~Example of past BOA Meeting Minutes is included in the Appendix.~~

Currently, the following are members of the CPATT's Board of Advisors:

1. Mr. Tim Smith, Director Technical Activities, Cement Association of Canada (Chair BOA 2012-2015)
2. Mr. Marcos Krocker, Director of Transportation, Regional Municipality of Waterloo
3. Mr. Doubra Ambaiowei, Executive Director, Ontario Hot Mix Producers Association
4. Ms. Becca Lane, Manager Materials Engineering and Research Office, Ministry of Transportation Ontario
5. Dr. Amir Halim, Principal, Infrastructure Management and Pavement Engineering, Stantec Consulting Limited (Chair BOA 2015-2017)
6. Mr. Tony Kucharek, Technical Director, McAsphalt Industries Limited
7. Mr. Bruce Armstrong, President, Canadian Asphalt Industries Inc. (Chair BOA 2017-2020)
8. Mr. Jim Kelly, Vice President, Capital Paving Limited
9. Mr. Mohammed Ahmed, Manager Quality Assurance, SNC Lavalin
10. Dr. Ludomir Uzarowski, Principal, Pavement and Materials Engineering, Golder Associates Ltd.
11. Mr. John Pontarollo, Senior Vice President Ontario & Western Canada, CRH (Canada) Inc.
12. Mr. Michael Mackay, Principal Engineer and General Manager, EnGlobe
13. Dr. James Smith, Manager Member/Technical Services, Ontario Good Roads Association
14. Mr. Alen Keri, Senior Pavement Engineer, Concrete Association of Ontario
15. Mr. Ted Arscott, President, Roto-Mill Inc.
16. Dr. John Emery, Owner, Shiloh CanConstuct
17. Mr. Malcolm Matheson, President, Steed and Evans Limited
18. Prof. Susan Tighe, Former Director of CPATT, Adjunct Professor, Former Norman W. McLeod Chair in Sustainable Pavement Engineering, University of Waterloo
19. Prof. Neil Thomson, Former Chair of Civil and Environmental Engineering, Ex-officio
20. Prof. Hassan Baaj, CPATT Director, Professor, University of Waterloo

CPATT Director

The CPATT Director is appointed by the Chair of the Department of Civil and Environmental Engineering. This is normally a tenured faculty member in the Department of Civil and Environmental Engineering. The Founding director was the late Professor Ralph Haas. Prof. Carl Haas and Prof. Susan Tighe have also both served as CPATT Directors until the appointment of the current Director, Prof. Hassan Baaj in 2017.

The primary responsibilities of the Executive Director, as established by the Board of Advisors and approved by Senate, include:

- Initiating and coordinating the research and education activities of CPATT;
- Developing strategic direction and ensuring that the strategic plan is followed;
- Establishing and maintaining linkages with associations, other research centers, and informing CPATT members about these activities;
- Assisting the Board of Advisors with on-going CPATT activities;
- Representing CPATT at industry events; and

- Report to the Board of Advisors, Dean of Engineering, and Chair of the Department of Civil and Environmental Engineering.

Senior Research Associate

Dr. Pejoohan Tavassoti, joined CPATT in 2017 as Senior Research Associate. Dr. Tavassoti's position is mainly funded by research grants obtained by Prof. Baaj and partially from CPATT's operating account.

The primary responsibilities of the Senior Research Associate include:

- coordinating and conducting CPATT's research contracts in the lab and field;
- hiring, training, and managing of co-op students assisting with contract work;
- assisting with graduate students' research;
- contributing to preparing research proposals and disseminating findings by preparing reports and presentations for clients; and
- assisting CPATT committees to meet their objectives.

Associate Director

The position of Associate Director has always been held by UW full-time faculty members. Prof. Baaj served as Associate Director for two years before his appointment as Director in 2017. As mentioned earlier, Prof. Shunde Yin candidature to serve as Associate Director will be discussed during the next BOA meeting.

> The Associate Director is responsible for the Centre's administration, conferences, branding, marketing, customer relationship management (CRM), newsletter and web content management, staffing, and finance. The Associate Director also provides leadership and oversight to the development and management of the Centre Pavement and Transportation Technology (CPATT).
>
> The Associate Director reports to the CPATT Director and the Board of Advisors and also works closely with the research team members.

Administrative/Financial Assistant

- Ms. Jessica Rossi, Financial and Administrative Officer, (Full-time - Aug. 2016 – Sep. 2017)
- Ms. Nicole Schmidt, Interim Financial and Administrative Officer, (Part-time - Sep. 2017 – Present)

Currently the post of Financial and Administrative Officer is vacant but Nicole Schmidt, Financial Assistant Research and Contracts at CEE, is helping with the financial administration of CPATT which has been a crucial and highly appreciated support from CEE.

The Administrative/Financial Assistant and duties include:

- ensuring that the Director and Associate Director are up-to-date on CPATT's day to day activities and that University and CPATT policies are implemented in a timely manner;
- maintaining financial records of budgets, expenses and income for the Centre's accounts to reconcile with the University financial system;

- working with co-op students; hiring, training, and supervising work-study students;
- liaising with CPATT BOA members to ensure deadlines and Centre's objectives are achieved. Responsibilities include: maintaining records related to CPATT, disseminating information on Centre's activities, initiating meetings, assisting in the preparation of reports;
- acting as a liaison between Board members and Director to ensure Centre's policies are properly followed;
- arranging and organizing conferences, workshops, seminars, and other events, both on- and off-site, sometimes in conjunction with other industry organizations.
- generating invoices, and collecting and processing payments for events and services through the Accounts Receivable and Accounts Payable system;
- setting up research contracts with Office of Research, and completing payments, and managing project finances;
- responsibilities for general office administration, including maintaining confidential files, and updating membership database;
- maintaining CPATT's website and ensuring that all required updates are completed promptly;
- maintaining office inventory, and purchasing office supplies; and
- performing other duties as assigned by the Executive Director, Technical Director/Research Associate and Associate Director as needed by the Board of Directors and Committees

Support Staff

Since 2015, CPATT has employed 26 students to assist with CPATT activities including Co-op students and Undergraduate Research Assistants to assist with the completion of research projects, contracts and other CPATT activities.

CPATT also promotes the involvement of engineering students in the pavement engineering field by encouraging CPATT members to hire uWaterloo co-op students, involving students in pavement projects and supporting student attendance at the annual students CPATT symposium, workshops and conferences.

Adjunct Professors

- Prof. Mohab El-Hakim, Manhattan College, USA
- Dr. John Emery, Shiloh CanConstuct
- Dr. Steve Goodman, Manager, Pavements and Materials, Gemtec
- Dr. Vimy Henderson, Director of Eastern Operations, PSI Technologies Inc.
- Dr. Li Ningyuan, Consultant, Retired from MTO
- Dr. Sina Varamini, Manager, Research & Development, McAsphalt Industries Limited

Other Active UW Members and other key contributors

Serval other UW researchers and faculty members have been involved in research projects in collaboration with CPATT including co-supervising graduate students, submitting joint proposals or participating in CPATT's seminars, symposia or other activities. The following is a list of some of these faculty members.

- Prof. Shunde Yin (Geotechnical)
- Prof. Giovanni Cascante (Non-Destructive Testing)
- Prof. Dipanjan Basu (Geotechnical, Soils)
- Prof. Adil Al-Mayah (Materials, Structures)
- Prof. Maria Anna Polak (Concrete Structures)
- Prof. Wei-Chau Xie (Risk and Reliability)
- Prof. Tarek Hegazy (Construction Management)
- Prof. Carl Haas (Construction Management)
- Prof. Jeff Casello (Transportation Planning)
- Prof. Scott Walbridge (Steel Structures)
- Prof. Sriram Narasimhan (Structural Dynamics)
- Prof. Bruce Hellinga (ITS and Traffic)
- Prof. Liping Fu (ITS and Traffic)
- Prof. Jean Andrey, Geography Dept., UW
- Prof. Goretty Dias, School of Environment, Enterprise and Development – SEED, UW
- Prof. Alan Carter, Ecole de Technologie Supérieure, Montreal, Qc
- Prof. Orazio Balgieri, Polytechnico di Torino, Italy

Budget and Financial Information

The original financing of CPATT's activities was realized through funding from CFI/OIT/Board of Advisors Partners/Norman W. McLeod Endowment for the research infrastructure, ORDCF/Partners for the operating requirements, and various projects again for operating needs. The original CFI and ORDCF budgets have been spent and the laboratory and field equipment is in place. In 2019, Prof. Baaj, together with five other researchers, have been awarded $130,000 for the retrofit of one of servo-hydraulic testing equipment at CPATT.

The information below presents a summary of the revenue and expenses of CPATT from May 1st, 2015 to Sep 11th, 2020.

At today's date, CPATT has a positive balance of $15,000. It should be noted that due to the pandemic interruptions, CPATT decided to suspend the annual Research User Fee and use some funds to support HQPs to protect them from the adverse effects of the lockdown and losing some highly experienced personnel. This indicates that the centre is not only self-sustainable but resilient to support the department goals during unexpected impacts.

Also, it is important to note that the Sales and Service Revenue, corresponding to technical services provided by CPATT to external clients (industry and consulting firms), has been stable with a positive trend in the last 5 years. The objective is to increase this type of service in the future.

	Fiscal Year					Fiscal YTD May 1 - Sept 15, 2020		
Account Group	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**Commitments**	**Available Funds**
Carryforward from Prior Year	(90,186)	(166,677)	(109,061)	(60,600)	(51,189)	(15,064)		
Budgetary Support		(17,652)	(50,789)	(50,000)	(10,000)			
Sales & Services Revenue	(54,100)	(4,000)	(15,000)	(31,317)	(93,138)	(24,429)		
Research User Fee	(105,530)	(83,275)	(91,050)	(42,503)	(11,562)			
Research account surplus resolutions		(70,989)						
Total Revenue	**(249,816)**	**(342,593)**	**(265,900)**	**(184,420)**	**(165,889)**	**(39,493)**	**0**	
Salaries-Faculty/Research Assoc/Post Doc	-	-	-	18,333	66,523	9,672	900	
Salaries – TA/RA	22,526	16,656	12,579	-	-			
Salaries-Staff	11,715	112,133	43,153	17,296	2,288			
Supplies & Others	9,041	30,813	30,922	37,250	43,439	4,094	8,835	
Travel & Hospitality	23,538	33,521	40,900	21,322	25,415	71		
Capital Assets Expense Accts			21,783					
Expandable Equip Purchases and Maintenance	16,318	33,909	20,053	22,829	10,661	542		
Scholarship & Bursaries		6,500	35,910	16,200	2,500			
Total Expense	**83,139**	**233,532**	**205,300**	**133,231**	**150,825**	**14,379**	**9,735**	
Balance (-/surplus, +/deficit)	**(166,677)**	**(109,061)**	**(60,600)**	**(51,189)**	**(15,064)**	**(25,114)**	**9,735**	**(15,380)**

Funding over the next five years is expected to come from the following sources:

- **Research projects user fee:** For each project conducted at CPATT, a user fee will be budgeted and collected to cover the operational cost of the lab. It is expected that this would generate a revenue of $50,000/year in the next five years.
- **Corporate Membership:** As the initial funding for CPATT and N.W. McLeod Chair has been completed this year and all the partners have paid their committed contributions, the intent is to propose the creation of corporate membership fee that will be open to current and new CPATT members. The membership will be divided into three levels: Platinum, Gold and

Silver and the membership fees will be $5,000, $5,500 and $2,000/year respectively. It is expected that the membership program will generate a yearly revenue of $30,000/year in the first year and should increase to $50,000 in year 5. This plan will be discussed during the next CPATT BOA meeting in October 2020.

- **Professional Training:** As recommended by several members from the BOA and other CPATT members, CPATT plans to start offering several professional training programs for pavement engineers and technicians, both in Canada and internationally. This started in 2020 with a joint training program with Ontario Hot Mix Producers Association and the Asphalt Institute, but his program has been postponed to 2021 due to Covid-19. In addition, CPATT started planning for the creation of a professional training program with China that would be extended to other countries. Dr. Li Ningyuan, adjunct professor at CPATT, has started initiating several contacts with Chinese universities and companies. The estimated revenue from training programs is expected to generate $25,000 in the first year that should ramp up to 50,000 in year 5.
- **Technical Services:** CPATT receives frequent requests for technical services including lab testing and technical studies. Thanks to the new RTI funding received in 2019, our testing capacity will increase which would lead to an increase in the revenue. It is expected that the annual revenue will be around $50,000/year in the next five years.
- **Other sources:** In addition to the aforementioned revenue sources, we will plan to continue to submit research proposal and applications for research tools, instruments and infrastructure through NSERC, CFI, ORF and other organizations.

CPATT's success has also resulted in the development of an endowed chair in the field of pavement engineering which led to the hiring of Prof. Hassan Baaj as the Associate Chair holder in 2014. Prof. Tighe's position is now vacant and the hope is to be able to hire a new faculty member who would join CPATT and contribute to attracting new collaborations.

Current funding sources of the Centre staff, namely the CPATT Research Associates and CPATT administrative assistant (vacant post since 2018) come from various research projects and Norman McLeod Chair. Primary funding sources include:

- NSERC
- Ontario Centre of Excellence
- Ministry of Transportation of Ontario
- Cement Association of Canada
- Ontario Hot Mix Producers Association
- McAsphalt Industries and Miller Paving
- Other industry partners

The table below summarizes the anticipated yearly budgets for CAPTT for the next five years:

Projected Yearly Budget for CPATT 2020-2025:

Account Group	2020/21	2021/22	2022/23	2023/24	2024/25
Revenue					
- Technical Services	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)
- Research User Fee	($50,000)	($50,000)	($50,000)	($50,000)	($50,000)
- Corporate Membership	($30,000)	($35,000)	($40,000)	($45,000)	($50,000)
- Training	($25,000)	($35,000)	($50,000)	($50,000)	($50,000)
Expenses					
- Salaries-Admin staff	$25,000	$26,000	$27,000	$28,500	$30,000
- Salaries-technical staff	$50,000	$50,000	$50,000	$50,000	$50,000
- Training-honorarium	$10,000	$14,000	$20,000	$20,000	$20,000
- Operational Expenses	$30,000	$30,000	$30,000	$30,000	$30,000
- Travel & Hospitality	$15,000	$18,000	$23,000	$26,000	$30,000
- Scholarship & Bursaries	$20,000	$20,000	$20,000	$20,000	$20,000
Balance (-/surplus, +/deficit)	($5,000)	($12,000)	($20,000)	($20,500)	($20,000)

Five-Year Research Plan

The five-year plan for 2020-2025 will focus on continuing to develop and expand on external collaboration and to focus on internal collaborations amongst faculty members in CPATT. This collaboration will be facilitated through regular monthly faculty meetings and meetings with the Board of Advisors twice a year. Each meeting will involve discussing a specific research theme which is of interest to the group.

CPATT's current research is diverse covering wide range of topics related to Pavement Engineering. In particular, our researchers were involved in research projects related to sustainability and environmental solutions in the field of transportation engineering materials and infrastructures. In addition, we were involved in several applied and R&D projects in the area of civil engineering infrastructures in general through our collaboration with several industrial partners. This allowed our researchers and students to work on multidisciplinary research projects in collaboration with several industry partners.

Future Research Plans: Rethinking the Road of the Future

The transportation system of a country has the same importance that the arteries, veins and nerves have to the human body. The health of this system is reflected in the development of the country. We must therefore preserve and grow the transportation systems to support the societal, economic and ecological needs in the future and to follow the technological advances in the transportation industry. A profound reflection on the road to the future is then essential.

Several organisations and international experts have started working on defining the road of the future. This road would be sustainable, resilient, connected, adaptable, self-healing, source of energy, smart and versatile. It will change its configuration according to the needs of traffic, communicate with users and lead them to their destination safely. This road would be modular, easy to build and repair. The road of the future would be depolluting and able to self-clear the snow and recover water from the rain. While all these ideas and others are very interesting, some are more urgent and important than others.

Our long-term research objective at UW is to pursue the research work that we started at CPATT on **Smart and Sustainable Transportation Engineering and take this area to a higher level**. The following paragraphs describe some research themes and topics that would feed CPATT's research roadmap in the upcoming years.

Proactive versus Reactive Pavements: Pavements are built today using mainly empirical or semi-mechanistic pavement design methods based on a number of assumptions and in some advanced methods, the values of stresses and strains in the different layers are calculated theoretically. However, the behaviour of the construction materials and the response of the structure may be much more complex than what is used to model and predict them. Huge errors may happen and lead to premature failures and huge financial losses. On the other hand, data collection methods used in Pavement Management Systems (PMS) are progressing thanks to the progress of new technologies, such as the use of automated data collection vehicles using 3D laser sensors or image analysis techniques. However, these techniques remain limited as they cannot predict the damage until it is actually visible on the surface. Proactive pavements are those that will send real-time information on stresses and strains, crack initiation and deflections, moisture levels, freeze and thaw conditions and traffic loading.

These smart and connected pavements are now possible thanks to the great technological advances in many areas. Very small wireless stress, strain and moisture gauges and weigh-in-motion sensors could be embedded in the pavement structure. Real-time data can then be remotely collected and analysed to help the engineers in timely decision-making process on pavement design adjustment or rehabilitation and maintenance.

Mechanistic Eco-design of Pavement Structures: Another main problem related to pavement design methods is that they do not allow adequate use of value-added products and innovative materials in pavement structures. In addition, researchers tend to generally address the two topics (Materials and Structure) separately. It is therefore important to create links and collaborate with academic and industrial peers with the aim of developing a global mechanistic structural pavement design approach that includes LCA models to allow for more economic and ecological pavement structures.

Alternative Binders: The road construction industry is strongly linked to the petroleum industry through the use of bitumen. However, the price of bitumen is increasing continuously and several studies predict the depletion of petrol within a few decades. Also, petroleum products have a profound impact on global warming and greenhouse gas emission. The business model of the chemical industry and the road industry may then become incompatible with sustainable development

in our societies in the future. In addition, the consumption of fossil Carbon has an undeniable impact on global warming and the greenhouse gas emission. In this context, the business model of the chemical industry seems to be incompatible with the sustainable development of our societies.

Several companies have already developed binders from alternative sources to oil to substitute bitumen. These binders are often expensive by comparison, not optimized for performance and are often difficult to produce. Extensive multidisciplinary research seems therefore necessary in order to overcome these difficulties and to come up with a durable and environmentally friendly alternative binder at a reasonable cost.

The Action Plan

Active CPATT faculty have expressed interest and serious discussion in pursuing a major research grant or centre of excellence in one of the theme areas. Discussions towards the creation of a research pole focusing on Smart and Sustainable Pavements have already started with several partners. Some of the partners have shown strong interest and Ontario Good Road Association has already accepted to commit funding towards the initiative. However, the project has been delayed due to several factor such as the freezing of research funding by MTO in 2018 and more recently Covid-19. Nevertheless, it is expected that a major collaboration grant will be prepared over the year.

In addition, there will be a concerted effort to pursue collaborations through the new NSERC Alliance Funding Program, Ontario Centres of Excellence and Mitacs. Many of the key researchers have already been involved with successful federal and provincial grants and with the collaborations under the CPATT umbrella, it is expected that several of the newer faculty members will participate with mentorship from senior faculty members within CPATT.

In addition, CPATT will continue to host national and international meetings, seminars and symposiums. The focus on research carried out by graduate students who work with CPATT faculty has been a huge success and this outreach will continue. Over the period of 2015 - 2020, 3 Graduate Student Symposiums were hosted in addition to a poster session in 2019 as part of the GRINCH Meeting. Copies of the abstract book are provided for the 2018 Graduate Student Symposium in the Appendix. These symposiums were very successful with well over 100 attendees in attendance at each symposium. They have also resulted in new collaborations with public and private sector organizations. This initiative will continue over the next five years.

Finally, technology transfer of research findings will be facilitated through a CPATT newsletter that will be published three times per year. Samples of CPATT's newsletters are contained in the Appendix. Currently there are over 1,500 subscribers from all stakeholder groups and although the majority of subscribers are in Canada and the United States, approximately 33% of the subscribers are based internationally. The newsletters highlight researchers, both faculty and students within CPATT. The website was redesigned in accordance with UW guidelines and continues to be updated on a regular basis. It is designed to highlight current research and that provides interested research sponsors with information on current competencies.

In short, the overall goal of CPATT over the next five years is to develop collaborative research partnerships and funding proposals. In addition, CPATT will work to expand the Board of Advisors

in broader technical areas including ITS, transportation, structures, and geotechnical. It is suggested that faculty members in the respective research areas would collaborate to develop those partnership in a similar manner as those in the pavement area. Finally, the goal for improved communication within CPATT will be facilitated through an up-to-date functional website and the development of a newsletter which highlights on going work by faculty members and graduate students. The goal of this communication will serve both as marketing but also as a tool for technology transfer.

Conclusion

The presence of CPATT provides a unique opportunity to bring stakeholders from a wide spectrum together (i.e., academia, government, associations, public and private sectors) which is crucial not only to fostering innovation in the pavement and transportation technology area but also to maximize the research impact through facilitating implementation of the results of the high-quality research conducted at CPATT. The centre also creates a synergy for collaborative research both nationally and internationally, which is well received by the scientific and professional communities internationally. The CPATT mission and brand name help attracting highly talented graduate students, researchers, and scholars to UW which reinforces all of the three main themes of the University's strategic plan for 2020-2025: i.e., 1) Developing talent for a complex future, 2) Advancing research for global impact, and 3) Strengthening Waterloo's diverse communities.

Attachments

1- Letter of Support Dean of Engineering

2- Letters of Support from active members of CPATT

3- The announcement poster for the GRINCH 2019 Symposium held by CPATT in April 2019

4- Copies of the Abstract Book of GRINCH 2019

5- The announcement poster for Rilem Symposium on High Performance Asphalt Materials held by CPATT in October 2019

6- ~~Example of past BOA Meeting Minutes~~

7- Asphalt Research Fund Delivers Bankable Results, Asphalt Magazine, Spring 2020

8- Samples of CPATT's newsletters

Secretary Note: Items 3-8 above are found here.

UNIVERSITY OF WATERLOO

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September 11, 2020

Senate Graduate and Research Council (SGRC)
Research Leaders Council
University of Waterloo

Subject: Letter of Support for renewal of the Centre for Pavement and Transportation Technology (CPATT)

Dear Members of the Senate Graduate and Research Council,

The Faculty of Engineering is pleased to strongly support the renewal of the Centre for Pavement and Transportation Technology (CPATT) for another five-year term.

CPATT is an international leader in pavement engineering research, implementation and education. They also serve our community of pavement engineers, academics and contractors as a critical nexus of knowledge management, networking and learning. With the leadership of the Former Director, Prof. Susan Tighe, and the current Director, Prof. Hassan Baaj, CPATT has become a significant asset to the University of Waterloo, the Faculty of Engineering and the Department of Civil and Environmental Engineering. As a research centre, CPATT provides a strong bridge between faculty members and Industry, as well as between graduate and undergraduate students and Industry. These industry linkages develop research funding opportunities, co-op positions, and assist with our goal to be recognized as an international leader in research, education and innovation. In 2019, CPATT hosted two major events; one is a national event (GRINCH Symposium) and the second is an international one (Rilem Symposium) which demonstrates the leadership role and the national and international recognition that CPATT has been able to acquire over the years.

Over the past five years CPATT has demonstrated exceptional growth in the area of pavement engineering, design and management. This impressive growth has been achieved while CPATT operated as a cost recovery Centre – it generates 100 percent of its revenue required to support the Centre operation without internal or external funds.

The Faculty of Engineering confirms its support for the renewal of the Centre for Pavement and transportation Technology for a new five-year term.

Sincerely,

Mary Wells

Mary Wells, Dean
Faculty of Engineering

E7-7302, 200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1

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Hassan Baaj, Ph.D., P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering

September 9, 2020

Re: Support Letter for the Centre For Pavement and Transportation Technology 2020 Renewal

I am very glad to write a letter of support for the Centre for Pavement and Transportation Technology (CPATT) at the University of Waterloo. I have collaborated with CPATT members on various projects over the years. We have shared equipment and ideas and these collaborations have proven to be extremely beneficial for my research output. The most recent joint project is on 3-D printing of concrete for application in building modern infrastructure . It is a novel and exciting application of additive manufacturing (3-D printing), which will benefit construction and transportation industries.

CPATT is a unique organization at the University of Waterloo, which provides a forum for research and education for many young engineering professionals. It is well managed, very active, organizes regular meetings and seminars with academia and industry, and brings together engineering faculty and students to conduct collaborative work related to transportation engineering and pavement materials.

I strongly support the renewal of CPATT and I look forward to continued collaboration with the Centre.

Regards,



Maria Anna Polak, PhD, P. Eng., FACI, FCSCE
Professor and University Research Chair
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Hassan Baaj, Ph.D., P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering

From: Li Ningyuan
Adjunct Professor, and former employee of Ministry of Transportation of Ontario

Date: September 3, 2020

RE: Experience and Suggestions in Supporting the CPATT of UW

As an adjunct professor, my comment on past experience of involving in CPATT research and operational activities is highlighted with a few examples showing remarkable values:

- Since the CPATT was formed in 18 years ago, it has been a symbol representing one of the worldwide recognized entities flagging up advanced transportation engineering and road asset management technologies. The CPATT of UW was initiated by super high-profile Canadian academia Ralph Haas and Gerhard Kennepohl, directed by well-known professors Susan Tighe and Hassan Baaj, supported by a large number of stakeholders and research institutes, and actively operated by all CPATT team members and graduate students.
- As a former senior pavement engineer at the Ministry of Transportation of Ontario (MTO), I had a long-term collaborated working relationship with the CPATT on MTO sponsored HIIFP research projects over the past 15 years, ranging from identifying research needs to delivering high-quality research products, which have been successfully applied to help tackle some of the technical issues and challenges to conserving Ontario's economy based road transportation system. The CPATT's individually specialized research teams have acted, as a consolidated entity, to provide the MTO with most valuable and cost-effective high-tech assistance to Ontario's transport system development.
- The CPATT has presented, representing an entity of the UW and Canadian educational and research entity, at many national and international conferences (such as TAC, CSCE, TRB, AASHTO, etc.), special seminars and symposiums, training programs, to showcase UW's transportation engineering and road asset management technologies through the CPATT in terms of accomplishments and contributions to the globe's transportation engineering, including state-of-the-art research infrastructure in areas of design, materials, construction, preservation, automation, safety, and management for developing new technologies, Training skilled people, technology transfer and sustained partnerships.

- The CPATT has earned a very good and honorable reputation not only in Canada but also in many other countries that are interested in seeking transportation engineering and road asset management educations and academic researches. Every year, it attacks a wide large number of engineering students, road construction industries, visiting scholars and post graduate researchers from the world.
- Also, I should appraise the CPATT's research collaboration with its partnership stakeholders in terms of involving external specialists and road engineering experts in its graduate student research programs, including research statements, comprehensive examinations and PH.D. student thesis review comments.

A couple of suggestions for supporting continuation of the CPATT research collaboration program:

- Provide more training programs and workshops focusing on practical road condition data collection, road materials engineering, road asset management applications as needed by many road agencies and individuals in the world
- Promotion of CPATT research programs through international collaboration with other universities, research institutes and industries in the world.

Li Ningyuan, Ph.D., P.Eng.
Professional Engineer and Adjunct Professor
University of Waterloo, Ontario, Canada
Tel: 416-570-6531
Email: NLI@uwaterloo.ca

September 10, 2020

Hassan Baaj, Ph.D, P. Eng.
Professor - Associate Chair for Research Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering

RE: Letter of Support for CPATT Renewal Application

Dear Hassan,

It is with great enthusiasm that I write this letter of support for CPATT's renewal application. As an adjunct assistant professor and former graduate student at CPATT, I am proud to consider myself member of a centre representing high caliber researchers and professors on national and international platforms; who all share the same vision of "providing practical and applied innovation to the pavement industry". This vision requires tremendous effort in engaging practicality and theoretically-sound innovation throughout different stages from idea evaluation to implementation and in-service assessment, which often get neglected at university-level research projects. However, CPATT team has demonstrated repeatedly for almost 20 years how to be a leader in combining innovation and practicality in a multitude of applications pertained to the transportation engineering. Such vision has been showcased in hundreds of journal publications and conference proceedings presented on national and international levels.

CPATT also represents a unique partnership between experts from the academia, industry and transportation authorities. This partnership is an essential platform for the pavement industry in Canada, as it provides a hub to identify research needs in building more sustainable and resilient transportation infrastructure. This partnership overtime has resulted in better incorporation of sustainability into industry practices, improving recycling and material characterization, and more importantly preparing the industry and its practices to deal with climate change.

CPATT has provided tremendous benefit to the industry by training University of Waterloo students to become the skilled professionals and future leaders that the industry needs. Such training has been accomplished by allowing students work and interact with industry experts on CPATT projects. It is important to mention that majority of today's successful leaders within the industry are those who were studied and trained at CPATT. This is certainly a legacy that is hard to accomplish and requires to be maintained.

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The pavement industry is going through fundamental changes including shortage of experts due to age gap and impacts of climate change. These challenges combined with developing sustainable practices for constructing and maintaining pavements created a need for CPATT more than ever. I strongly support CPATT renewal and look forward to continuing my collaborative work with the team and feel very enthusiastic about the next five years achievements and accomplishments.

Sincerely,



Sina Varamini, Ph.D, P. Eng.
Adjunct Assistant Professor – Centre For Pavement and Transportation Technology
Civil and Environmental Engineering
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September 3, 2020

Hassan Baaj, Ph.D., P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering

Re: Letter of Support for the Renewal of Centre For Pavement and Transportation Technology (CPATT)

It is with pleasure that I am providing a letter of support for the Centre For Pavement and Transportation Technology (CPATT) at the University of Waterloo. I have interacted with CPATT for over eight years and have had meaningful interaction regarding research and industry connections. Currently, pavement engineering and the transportation sector have significant impact in the Civil Engineering profession and CPATT stands as a premier center for generating and disseminating knowledge in this area. CPATT's initiatives in conducting workshops and seminars are commendable. I believe that CPATT is a well-managed center, plays an important role in developing novel technologies and connecting to the industry partners, and is an important part of UW.

I strongly support the CPATT's renewal and look forward to having more fruitful interactions.

Sincerely,

Dipanjan Basu

Dipanjan Basu, Ph.D., P.Eng.

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University of Waterloo

September 2, 2020

Hassan Baaj, Ph.D., P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering

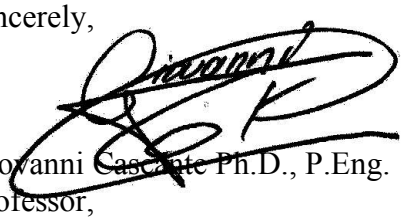
Re: Support Letter for the Centre For Pavement and Transportation Technology 2020 Renewal

It is my pleasure to provide a letter of support for the Centre For Pavement and Transportation Technology (CPATT) at the University of Waterloo. Over the past six years, CPATT has allowed me to connect to industry partners to obtain research funds, data, and to understand better the transportation industry needs in the area of non-destructive evaluation of pavements. CPATT regularly host industry workshops and seminars; which provide an opportunity to connect with industry and to present my research results.

CPATT has been and continues to provide unique organization at the University of Waterloo.

CPATT is a well-managed Centre; and it has been a pleasure to see it to continue to grow over the years. I strongly support the Centre renewal and to continue to take advantage of industry and research initiatives at CPATT.

Respectively submitted.
Sincerely,



Giovanni Cascante Ph.D., P.Eng.
Professor,
Civil and Environmental Engineering Department

PSI Technologies Inc.

September 11, 2020

Hassan Baaj, Ph.D, P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director – Centre For Pavement and Transportation Technology
University of Waterloo
200 University Avenue West, Waterloo, ON, Canada, N2L 3G1
Phone #: (519) 888-4494
E-Mail: hbaaj@uwaterloo.ca

Dear Dr. Baaj,

I am pleased to provide this letter to share my experiences with the Centre for Pavement and Transportation Technology (CPATT), as well as my support in its continuation. I have been involved in CPATT since its initiation in 2005. CPATT has provided a tremendous contribution to the pavement and materials industry, not only in Canada, but globally. Having developed industry members that are now in private and public sector and academic leadership roles around the world.

My involvement with CPATT started as an undergraduate co-op student. I then continued on to do graduate studies. I was fortunate to have the opportunity to use many of CPATT's resources during my doctorate degree. During the time I was involved with CPATT, I had the opportunity to meet various industry members. As a result, I received a job offer prior to even completing my studies. I have now moved into the role of Director of Eastern Operations at PSI Technologies Inc. I utilize my industry network from CPATT almost daily. CPATT has developed many highly skilled professionals while carrying out quality research. I encourage you to continue this valuable program in the future.

Should you have any questions, please contact me at vhenderson@pavesci.com or 519-661-7332.

Kind regards,

Vimy Henderson

Vimy Henderson, Ph.D., P.Eng.
Director of Eastern Operations, PSI Technologies Inc.

UNIVERSITY OF WATERLOO

September 2, 2020

Hassan Baaj, Ph.D., P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering

Re: Support Letter for the Centre For Pavement and Transportation Technology 2020 Renewal

I'm pleased to provide this letter of support for the Centre For Pavement and Transportation Technology (CPATT) at the University of Waterloo. Over the past three years, CPATT has provided me with the opportunities to access the research facilities as well as opportunities to connect to industry partners to obtain research funds, data, and. A most recent project titled "Evaluation of geosynthetic reinforced pavements by field and laboratory testing integrated with thermo-hydro-mechanical modeling" funded by NSERC Alliance Program is attributed to the connection between CPATT and TITAN Environmental Containment Inc. CPATT regularly hosts industry workshops and seminars and provides a platform for academics to communicate effectively with industry. The most recent domestic and international conferences that are hosted by CPATT and I attended are the GRINCH Pavement Engineering Research Symposium 2018 and the RELIM High Performance Asphalt Materials 2019. From these conferences I was able to interact with the researchers and engineers and discuss the most challenging problems in pavement engineering.

Based on my observation and my experience in academia in USA and Canada over the last twelve years, CPATT is the best managed and most successful Centre in a university. I strongly support the Centre renewal and to continue to take advantage of industry

support and research resources constantly initiated and generously offered by CPATT.

Please feel free to let me know if more information is needed.

Sincerely,



Shunde Yin
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CIVIL & ENVIRONMENTAL ENGINEERING

Dr. Mohab El-Hakim
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Bronx, New York 10463
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September 10, 2020

Hassan Baaj, Ph.D., P. Eng.
Professor - Associate Chair for Research
Norman W. McLeod Professor in Pavement Materials
Director - Centre For Pavement and Transportation Technology
Civil and Environmental Engineering
hassan.baaj@uwaterloo.ca

Re: Support Letter for the Centre For Pavement and Transportation Technology 2020 Renewal

Dear Dr. Baaj,

I am delighted to write this support letter for the renewal of the Centre For Pavement and Transportation Technology (CPATT) at the University of Waterloo. CPATT represented a crucial connection between academia and industrial firms in the transportation and highway construction sector. The applied research projects performed by CPATT members are industrial-driven to meet current and future needs to maintain and improve the Canadian transportation infrastructure. The research produced by CPATT is world renowned and well recognized through publications in top scientific journals. CPATT hosted international conferences, seminars and pave-in events where it offered our Canadian industrial partners the opportunity to expand their technical knowledge by collaboration with top academic institutions in Canada and overseas.

The growth of CPATT in the past decade reflects the clear and ambitions vision of the current management. I strongly support the Centre renewal and further development of industrial-academic collaboration on applied research projects.

If you have any questions or require further information, please do not hesitate to contact me.

Sincerely yours,

Mohab El Hakim

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