2025 CTAA Conference: Overview of Technical Program

The following papers have been selected to be presented at the 2025 CTAA Conference.

Title and Author(s)	Abstract
High skid resistance asphalt wearing course on Vancouver YVR airport runway **Main Author:** Kevin Bowyer **Other Authors:** Shirley Ddamba, Jacques-Antoine Decamps, Amelie Griggio, Marc Proteau	Runways are designed to accommodate both narrow-bodied and wide-bodied aircraft, which require uniform coefficient of friction and texture for safe operations. With such large aircraft landing at high speeds, good skid-resistance parameters must be maintained. Several authorities have defined precise specifications on the requirements for skid resistance/mean texture depths and formulation approaches, particularly for asphalt-wearing courses. The Vancouver Airport Authority's Engineering Department sought to develop new specifications for an asphalt-wearing course surface that could provide high skid resistance on specific maintenance work on their concrete Runway. This maintenance work involved repairing broken concrete slabs with 75mm to 100mm (3"- 4") of Hot-Mixed Asphalt Concrete (HMAC). In November 2023, BA Blacktop, a subsidiary of Vinci Construction, and YVR's main maintenance contractor, was approached for technical collaboration with YVR's engineers. The Vinci Group's Americas Technical Center (ATC) was involved in the development of formulation specifications for a surface-wearing course as well as a complete laboratory performance measurement test plan. A comparative formulation study between conventional asphalt mixes using a 0-19 mm and 0-12.5 mm HFM formulation with and without the addition of synthetic fibres was carried out. The special study focused on maintaining the long-term performance of resistance to loss of adhesiveness on specimens submerged in water and surface shear resistance with the DSD test was conducted. Finally, initial rehabilitation work was carried out in March 2024 on Runway 08L-26R to replace damaged concrete slabs with the new 0-12.5 mm HFM asphalt mix and skid resistance measurements were subsequently carried out to validate the new wearing course solution.

Title and Author(s)	Abstract
Towards Practical Balanced Mix Design in Ontario: Addressing Interlaboratory Variability and Optimizing Rap Utilization – Ontario Mix Asphalt Program Study **Main Author:** Sina Varamini **Other Authors:** Doubra Charles Ambaiowei, Selena Lavorato, Prahbdeep Lubana, Pejoohan Tavassoti	The Ontario Asphalt Pavement Council (OAPC), a council of the Ontario Road Builders' Association (ORBA), is dedicated to improving asphalt pavement performance across Ontario. Through the Ontario Asphalt Expert Task Group (OAETG), the council is working to bridge knowledge gaps in performance-based acceptance, aiming to establish a comprehensive framework for performance-based mix design and evaluation. A cornerstone of this effort is the Ontario Mix Asphalt Program (O-MAP), developed in response to findings from the Ministry of Transportation Ontario (MTO), which identified preliminary performance thresholds for heavy-duty mixes, including the PG70-28XJ Superpave FC2 mix. One of the key challenges highlighted by O-MAP is the current limitations of laboratory capabilities, particularly in conducting advanced tests such as the Hamburg Wheel Tracking Test (HWT) and the Semi-Circular Bend Test (SCB). Recognizing these gaps, O-MAP emphasizes the importance of enhanced research, training, and collaboration to advance testing methodologies. The program's initial phase concentrated on evaluating the stiffness of the SP 12.5 FC2 surface mix, driven by concerns over cracking and compliance with the MTO's strict performance thresholds. Results from the first testing phase revealed significant variability in outcomes, particularly in HWT and SCB tests, though low-temperature cracking tests produced acceptable results. However, no laboratory successfully met the proposed rut depth threshold during Hamburg testing, raising questions about the feasibility of MTO's criteria. To address these issues, a second round of testing began in 2021, utilizing controlled plant-produced mixes to pinpoint sources of variability across laboratories. While this phase slightly reduced variability, it underscored the critical roles of technician expertise, equipment condition, and strict adherence to procedures in achieving consistent results. Variability in specimen preparation methods led to significant differences in performance assessments, complicating the adoption of the Balanced Mix Design (BMD) approach. Despite these challenges, the tested heavy-duty mixes demonstrated strong field performance on Ontario highways, suggesting that refining laboratory procedures could better align testing outcomes with real-world performance. This paper presents a detailed analysis of the findings from O-MAP Round 3, exploring the ongoing challenges in balancing mixes for performance and proposing innovative strategies to mitigate these issues. The results highlight the importance of collaboration among stakeholders to refine testing methodologies and enhance the broader application of performance-based tests in future contracts. This work aims to provide researchers and practitioners with critical insights, fostering further advancements in asphalt mix evaluation and supporting the continuous improvement of asphalt pavement quality in Ontario.

Title and Author(s)	Abstract
Eight-Year Performance of Ontario's LTPP SPS-10 Warm Mix Asphalt Pavement Sections **Main Author:** Seyed Tabib **Other Authors:** Gabe Cimini, Larry Wiser, Saeid Salehi, Stephen Lee	The Ministry of Transportation of Ontario (MTO) has been paving Warm Mix Asphalt (WMA) on its paving contracts since 2008. A review of asphalt pavement performance has revealed that, compared to Hot Mix Asphalt (HMA), WMA performs better in terms of centreline joint quality. Field and laboratory evaluations indicate that WMA is a viable alternative to HMA, supported by over 10 years of performance data. The life-cycle cost of WMA is expected to be equivalent to or lower than that of HMA.In 2013, the U.S. Federal Highway Administration (FHWA) introduced its tenth Specific Pavement Study (SPS-10) as part of its Long-Term Pavement Performance (LTPP) plan. The study, titled "Warm-Mix Asphalt Overlay of Asphalt Pavements", was designed to evaluate the long-term field performance of WMA relative to HMA. Production and placement of the WMA had to be at or below 135oC, or at least 16oC less than the HMA.In 2014, the MTO participated in the SPS-10 study, along with other participating states having a wet-freeze climate, by selecting five full-width test sections on an 8.2 km stretch of Highway 48, located approximately 40 km north of Toronto. All sections included 15% Reclaimed Asphalt Pavement (RAP) in the surface and binder course lifts. The sections included: • One HMA control section • One WMA section produced using foaming process • Two WMA sections produced with different chemical additives • One WMA section produced with an organic additive The sections were reviewed and accepted by the FHWA. Construction began in 2016 and was completed in June 2017. The ministry was responsible for the construction of the sections. The FHWA, through their consultant, Stantec Consulting Inc., is responsible for collecting performance data, conducting materials testing, and providing data analysis and reporting for 15 years. The resulting data is stored in the LTPP database and is available online at the LTPP InfoPave™ web portal (https://infopave.fhwa.dot.gov/)". The study's objective is to investigate the sensitivity and performance of WMA sections considering moisture damage, low-temperature cracking, fatigue cracking, and permanent deformation. The primary factors are climate, traffic loading, and WMA mix design. Secondary factors are in-situ density, Reclaimed Asphalt Pavement (RAP) content, subgrade type, existing pavement condition, roadway geometry, and layer thickness. This paper provides an overview of the construction data, materials testing results, and eight-year pavement performance of the aforementioned test sections.
MTO's Mix Performance Testing History and Roadmap Towards	The Ontario Ministry of Transportation (MTO) initiated a comprehensive mixture performance testing evaluation program on post-production asphalt mixtures and pavement field cores. The goal of this initiative was to identify practical mix performance tests, benchmark current mixtures, and establish

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Implementation of Balanced Mix Design **Main Author:** Imran Bashir **Other Authors:** Saeid Salehi, Gelu Vasiliu	preliminary threshold criteria to mitigate fatigue and low temperature cracking, and rutting. Cracking of asphalt pavement is a major concern in cold climate regions, which can be initiated by several factors including asphalt cement additives/modifiers, recycled materials content, materials variability, and construction processes. Traditional volumetric asphalt mix design is becoming more complex driven by the increased use of recycled materials and additives, such as reclaimed asphalt pavement (RAP), warm mix asphalt (WMA) additives, rejuvenators, and anti-strips. Superpave mix design face limitations in durability and performance and allows the mix designer to select a mix with less asphalt cement, therefore performance-based testing methods are needed. In Ontario, contractors are responsible to do the mix design on ministry jobs. To address these challenges, ministry has adopted fracture mechanics-based testing methods including the Flexibility Index Test (FIT) and Disk-Shaped Compact Tension (DCT) test to assess critical performance factors including, intermediate-temperature cracking, and thermal cracking at low temperatures, respectively, while the Hamburg Wheel-Tracking (HWT) test is being utilized to evaluate rutting resistance and moisture damage. The transition to a Balanced Mix Design (BMD) method for asphalt mixes in Ontario represent a significant shift from conventional Superpave method and will require a multi-step approach and these mix performance tests will become elements of the framework for BMD adoption and quality assurance (QA) acceptance testing. This phased approach will give time to gain confidence in the shift from volumetric to performance mix design. As part of this mix performance testing (MPT) initiative, a non-standard special provision covering the requirements for sampling and testing of hot mix asphalt for MPT testing and laboratory testing procedures have been developed. MPT interlaboratory correlations studies are also being conducted by the ministry to improve repeatability and reproducibility of mix performance tests across QA and industry laboratories. Collaboration with the Canadian Council of Independent Laboratories (CCIL) is underway to establish a certification program for technicians and laboratories conducting MPT testing and BMD, ensuring consistency and reliability in BMD testing and analysis across the province. This paper outlines the progress of the key tasks that MTO has successfully completed and is executing to facilitate the implementation of BMD by the industry, aligned with the Federal Highway Administration's (FHWA) eight tasks framework. The adoption of BMD will transform traditional Superpave volumetric mix design, improve pavement quality and foster innovation. Successful implementation depends on ongoing validation, specification refinement and establishment of a robust quality assurance framework.

Title and Author(s)	Abstract
Impacts of Gradual Aggregate Relative Density Changes on Asphalt Mix Design and Performance: A Long-Term Case Study **Main Author:** Sheldon Klassen **Other Authors:** Lindsay Johnston, Art Johnston	Generally, combined aggregate relative density and design asphalt content remained consistent for a long-standing, single plant asphalt supplier from 1996 to 2020. However, around 2017, quality control (QC) tests began to deviate from typical design values, causing difficulties in maintaining specification compliance with basic plant modifications. This prompted additional testing and review of the mix designs. It wasn't until the historic results of the plant mixes and aggregate property data were compared that we realized that seemingly minor changes in aggregate relative density over many years, had gone unnoticed but created significant changes to the mixes. Typically, we would expect an asphalt mixture at design gradation and design asphalt content should exhibit design volumetrics such as air voids, VMA (Voids in Mineral Aggregate), VFA (Voids Filled with Asphalt), and binder absorption. This had reliably been the case with this client for decades with only minor changes required to mix designs to meet changing specifications or component property data. However, in 2020 we noted that volumetric test results obtained from QC data showed persistent low air voids, despite adjustments to asphalt content and gradation, which suggested larger modifications or detailed mix review would be required. The initial results of our multi-laboratory investigation into the aggregate properties determined that the aggregate relative density had been fluctuating for years with a significant decrease in 2020 despite supplier reporting no change in aggregate source. The decreased relative density prompted a recalibration of the mix design parameters, including adjustments in aggregate gradation and increase to the binder content. The new lower relative density was causing increased dust through plant breakdown and with the higher absorption of the aggregate and higher dust content it necessitated additional asphalt binder to achieve the desired volumetric properties. This change had gone largely undetected for several reasons: • Local specifications require mix designs only needing to be updated every 3 years, so infrequent aggregate testing and mix verification was being complete • This supplier was reluctant to use any dust mitigation strategies such as additional screening, washing or modifications to baghouse systems. • The inherent variability of relative density testing of aggregates which may have resulted in overlooking small changes over time. In 2020, the new mix designs incorporating this information increased design asphalt content by 0.3-0.5%. A variable belt returning dust from the baghouse was also installed to reduce dust introduction back into the mix. The plant operations also adjusted their stockpile layout to ensure any dust emanating from the plant was not blowing onto stockpiles. These measures stabilized the mixes, ensuring specification compliance over the next 3 years. The updated mix design addressed the immediate issues of low air voids and increased dust, but consequently also increased the added asphalt binder and the cost.

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	This case study details the steps taken to address the aggregate changes, and increased asphalt content, emphasizing the real-world financial implications of variability in basic mix design properties, asphalt binder costs, and project stability.
MTO's Experience in Reducing Greenhouse Gas Emissions by Using a Specification Mandating Warm Mix Asphalt **Main Author:** Warren Lee **Other Authors:** Dariusz Wodala, Gelu Vasiliu	The Ministry of Transportation of Ontario (MTO) began preliminary research on the application of Warm Mix Asphalt (WMA) to Ontario roads in 2006. Between 2008 and 2009, MTO placed a total of 7,000 tonnes of WMA in five MTO contracts. Expanding upon its initial success, MTO constructed ten WMA contracts in 2010 by placing a total of 63,000 tonnes of WMA along with some Hot Mix Asphalt (HMA) control sections. A 10-year pavement performance review for these ten contracts revealed that WMA and HMA sections were performing equally. In 2012, MTO adopted a permissive specification allowing contractors to use WMA in lieu of HMA in paving contracts. In 2021, MTO developed a new specification mandating WMA reducing greenhouse gas (GHG) emissions. This new specification contains a list of permitted WMA additives, production temperature limitations at the asphalt plant, and requirements for stack emission measurements. In addition, asphalt fumes (particulate and soluble matter) measurements during paving operation are required. Compaction temperatures behind the paver are also recorded. Between 2022 and 2023, this WMA specification was incorporated in seven paving contracts across Ontario with a total of 108,500 tonnes of WMA being paved. Each contract included HMA control sections along with WMA to evaluate the performance and environmental benefits. This paper provides an insight on MTO's efforts to validate the reduction of GHG on these seven WMA contracts through an analysis of the plant production temperatures and stack emissions data, in addition to asphalt fumes measurements at paving sites.
Determining the binder content of reclaimed asphalt pavement using the ignition oven **Main Author:** Jean-Philippe Fortin **Other Authors:** Félix Doucet	Determining the binder content of reclaimed asphalt pavement (RAP) using the ignition oven can be quite tricky without a proper correction factor. Indeed, asphalt mix testing with the ignition oven requires a correction on the results because they tend to be higher than the real asphalt binder content. This proves to be challenging for agencies, who often must rely on extraction methods using a solvent for RAP, since the correction factor is unknown. These solvents usually have health and environment related issues. Therefore, eliminating their use is beneficial for agencies. So, if an agency wants to replace the use of a solvent by the ignition oven, it cannot simply use uncorrected results from the oven. This would most likely overestimate the asphalt binder content of the RAP, thus reducing the virgin asphalt binder added to the mix. That could lead to early pavement failures and prove to be quite costly for agencies. The Ministère des Transports et de la Mobilité durable of Quebec has developed a method using the ignition oven with the

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	theoretical maximum specific gravity (Gmm) to determine the binder content of RAP. The results obtained from the study allowed the development of an equation, which gives RAP bitumen percentages with a smaller variation than the uncorrected results directly obtained from the ignition oven. The equation considers the Gmm of RAP, which can be obtained with a basic Rice Test. Then a correction factor (not from the ignition method) between the burnt RAP Gmm test result and the effective specific gravity of the RAP aggregates is established. This approach was developed from the results of fifty-seven different RAP sources from the province of Quebec and proves to work well. The province of Quebec currently uses a solvent test method for determining the RAP asphalt binder content, and the method using the ignition oven with the RAP Gmm and the developed equation is close to it. It is also important to keep in mind that the solvent test method also has a few flaws, such as a fixed correction factor for RAP, which is not totally true. It would be interesting to know if the found equation with the ignition oven gives good results with RAP sources from other provinces.
Evaluation of Asphalt Binder in the High Stiffness Region for Low Temperature Performance using the DSR in place of the BBR **Main Author:** Geoffrey M. Rowe **Other Authors:** Tom Bennert, Walaa Mogawer and Wes Cooper	The use of the BBR for PG grading has been adopted since its introduction in the early 1990s. However, compared to the DSR, this device requires more aged binder and the need for additional equipment. Many agencies have been investigating alternate methods to estimate low temperature properties. For example, Maine DOT and others have been investigating the iCCL approach whereas Texas has suggested the use of DSR measurements at cold temperatures. Others have suggested that the use of a DSR specimen with a 4mm diameter offers a suitable alternative. The use of alternate methods is significantly more feasible today, over thirty years after the SHRP program that developed the BBR, with the improvements to instrumentation that has occurred. However, compared to previous approaches, the authors have made use of the standard 8mm configuration in the ASTM D7175 method but with the use of a lower strain magnitude in the testing. The background to the BBR use and interrelationships are to be discussed. Two methods are presented that can yield significant binder QC data and provide a rational basis for binder testing and grade evaluation without use of the BBR. Use of time-temperature (t-T) relationships are discussed to explain the theoretical justification. Excellent simple correlations are presented providing a direct calculation approach without the need for sophisticated software or a need to use t-T relationships.

Title and Author(s)	Abstract
Validation of asphalt cements and asphalt mixtures ageing using Fourier transform infrared spectroscopy (FTIR) **Main Author:** Gelu Vasiliu **Other Authors:** Abeo Edinboro, Heera Shakya, Luke Atkinson, Ann Holt	Ministry of Transportation Ontario (MTO) was the first Canadian agency adopting in the 1990's the Performance-Graded Asphalt Cement (PGAC) specification developed by the Strategic Highway Research Program (SHRP). The specification was based on research conducted by SHRP on "neat" asphalts cements for across North America and utilizes rheological testing to characterize chemical composition changes of asphalts cements in various stages asphalt mixtures "life" (i.e., mixing, transport, placement, in-service, etc.) to predict and ensure pavement resistance to rutting, fatigue and thermal cracking. The short-term aging is simulated by the Rolling Thin-Film Oven (RTFO), while the long- term aging is simulated by the Pressure Aging Vessel (PAV) following the RTFO. Since the implementation of the SHRP PGAC specification, the formulation and manufacture of asphalt cements used in pavements has changed significantly. The growing demand for fuels and other petroleum-based products led to changes in refining practices and the use of a wider range of crude oil sources. In addition, various modifiers were increasingly being used to produce asphalt cements: polymers, polyphosphoric acid, re-refined engine oil bottoms (REOB), paraffinic base oils, etc. Since 2000, excessive pavement cracking has become a recurrent problem around Ontario and elsewhere in North America, leading agencies to conduct research and adopt specifications to address it. Some agencies introduced additional tests after the 20 hours PAV (PAV20) while others considered increasing the PAV aging period to 40 hours (PAV40). Other agencies focused on the asphalt mixtures by using a Balanced Mix Design (BMD) approach using various Mix Performance Tests (MPT).In some cases, the asphalt mixtures used in these tests are subjected to short-term and/or long-term aging. Fourier transform infrared (FTIR) spectroscopy is a quick and powerful methodology to characterize the chemical composition changes in asphalt cements , especially invalidation of asphalt cements and asphalt mixtures subjected to laboratory and field ageing. The paper will examine the RTFO, PAV20 and PAV40 aging of Ontario manufactured asphalt cements, laboratory prepared blends and asphalt cements recovered from plant -produced asphalt mixtures and Reclaimed Asphalt Pavement (RAP).The study also include the effects of AASHTO based laboratory short-term and long-term aging on plant produced and laboratory prepared asphalt mixtures.

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Assessing Pavement Design Temperatures and Performance Grades in Atlantic Canada **Main Author:** Chris Barnes, Ph.D., P.Eng. **Other Authors:** Shahrul Ibney Feroz, M.Eng.	The selection of high and low pavement design temperatures for asphalt pavements is typically based on baseline highway performance grades established for Superpave mix design. Traditionally, these grades have been determined using tools such as LTPPBind Online, which correlate air temperature data with near-surface pavement temperatures. This study analyzes actual pavement temperature data collected from Road Weather Information Systems (RWIS) at 128 locations across Atlantic Canada. Similar to LTPPBind, design temperatures were determined using the 98th percentile approach, considering the average annual maximum 7-day peak temperature and the annual minimum temperature for each RWIS site over time. However, while LTPPBind assumes a constant mean temperature and standard deviation for each location, this study observed and modeled changes in mean temperature over time, allowing for projections of future design temperatures and performance grades. Incorporating climate change effects through real-world pavement temperature monitoring is recommended to reduce variability in current performance-graded binder selection models. This approach is expected to improve the reliability of forecasts regarding when asphalt binder grade requirements may need to be adjusted for a given region.
Establishing Performance Thresholds for Asphalt Mixtures in New Brunswick: A Step Toward Balanced Mix Design Implementation **Main Author:** Moein Biglari **Other Authors:** Xiomara Sanchez	Asphalt pavements have become more reliable and of higher quality thanks to advanced performance tests introduced in recent years. The balanced mix design (BMD) approach has gained considerable attention on an international scale. The BMD is a significant step forward in pursuing better-performing asphalt mixtures. This method replaces traditional volumetric design with performance testing criteria that address the most common distresses, such as rutting and cracking. This study aimed to evaluate the asphalt mixtures used in New Brunswick to establish thresholds as a significant step toward adopting the BMD approach. For this purpose, asphalt cores were extracted from six in-service pavement sections in the province. Rapid Shear Rutting Test (Ideal RT) and Hamburg Wheel Tracking Test (HWTT) were utilized to assess the rutting potential of mixes at high temperatures. The Indirect Tensile Asphalt Cracking Test (Ideal CT) and Semi-Circular Bending (SCB) Test were employed to investigate the fracture performance of mixes at intermediate and low temperatures, respectively. The results of the Ideal CT test revealed that asphalt mixtures using polymer-modified binder had the highest CTIndex and fracture energy (Gf) and the best resistance to deformation according to the Ideal RT and HWTT test, where these mixes demonstrated excellent resistance to rutting and stripping. The mix with the highest asphalt content, 6.3%, and 15% RAP exhibited the highest fracture energy in the SCB test to evaluate low-temperature cracking potential. Finally, using road survey data collected by the Automatic Road Analyser (ARAN) and the experimental results of the mixes, the final thresholds were determined as acceptance criteria for the province of New Brunswick. Two different approaches were used for establishing the thresholds. The first was a conservative approach, while the second was an average-based approach. The

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	level of aging and the variability of the tests were considered. In the conservative approach, the final thresholds were set at 25, 265, and 660 J/m² for the RT Index, CT Index, and fracture energy of SCB specimens, respectively, while these values were 40, 635, and 1460 J/m² for the average-based approach.
Evaluation of the Thermo-Mechanical Performance at High and Low Temperature for Flexible Warm Mix Asphalt **Main Author:** Wesam Al-Falahat **Other Authors:** Taylor Lefebre, Parinaz Ataeian, Prabhdeep Lubana, Alan Carter	There has been an increasing demand for warm mix asphalt (WMA) with lower production and compaction temperatures as a sustainable option that aims to preserve binder performance while reducing greenhouse gas (GHG) emissions. Among the various WMA technologies, flexible warm mix asphalt (FWMA) stands out due to its ability to offer improved performance across a wider temperature range, making it particularly suitable for harsher environmental conditions, such as colder climates or heavy traffic loads. FWMA provides enhanced flexibility and resistance to temperature-related distress, ensuring long-term durability and improved pavement performance. This study focuses on evaluating the thermomechanical performance of FWMA at both high and low temperatures through laboratory and field investigations. The research includes a comparative analysis of different performance testing methodologies used to assess both high-temperature rutting resistance and low-temperature cracking susceptibility. The laboratory tests conducted in this study include Hamburg Wheel Tracking (HWT), Asphalt Pavement Analyzer (APA), and French Rutting Tester (FRT) to measure rutting resistance at elevated temperatures. Additionally, the Thermal Stress Restrained Specimen Test (TSRST), Semi-Circular Bending (SCB), and Disc-Shaped Compact Tension (DCT) tests are utilized to evaluate the fracture resistance and thermal cracking potential of the asphalt mix at lower temperatures. These tests are essential in determining the ability of FWMA to withstand the combined effects of temperature fluctuations, traffic loads, and long-term aging. Beyond the laboratory assessments, this study also involves a field investigation where a full-scale road section has been constructed using FWMA. The selected road was paved with this specific FWMA mixture to assess its real-world performance under actual traffic and environmental conditions. By integrating laboratory evaluations with field performance monitoring, this study provides a comprehensive understanding of FWMA's effectiveness as a sustainable paving solution. The results will contribute valuable insights into the feasibility of FWMA for widespread application, offering practical guidelines for engineers and decision-makers in pavement design and construction. The combination of reduced emissions, improved durability, and enhanced resistance to temperature-related distress positions FWMA as a promising alternative to conventional hot mix asphalt (HMA), particularly in regions requiring more adaptable asphalt solutions.

Title and Author(s)	Abstract
Is Recovered Asphalt Cement (RAC) a Better Indicator than Performance Grade Asphalt Cement (PGAC) for Predicting Pavement Distresses? **Main Author:** Ahmad Nawaz Khan **Other Authors:** Heather Bell, Warren Lee, Gelu Vasiliu	Asphalt cement is a key component of the flexible pavements and it's exposure to extreme weather conditions that are becoming hotter in summer and less predictable in winter may adversely affect the pavement longevity due to premature thermal and fatigue cracking. Asphalt cement comprised of heterogeneous mixture of alike yet different hydrocarbon molecular associations forming saturates, resins, aromatics, and asphaltenes. Aging of asphalt cement in the field affects its rheology by altering the chemical structure to highly polar substances and in turn deteriorate the pavement performance over the repeated freeze-thaw cycles. To predict the performance and quality of asphalt cement, U.S. Strategic Highway Research Program (SHRP) developed the SuperpaveTM specifications that was adopted as American Association of State Highway and Transportation Officials (AASHTO) standard M 320. The Ontario Ministry of Transportation (MTO) implemented AASHTO M 320 acceptance criteria but soon realized the unresolved challenge of premature and excessive cracking in Ontario. MTO initiated research projects to investigate the premature cracking that ultimately resulted in an improved asphalt cement specifications by integrating Double-Edge Notched Tension (DENT) test and Extended Bending Beam Rheometer (EBBR) test. MTO investigated field trials on paving contracts by adopting DENT and EBBR tests for RAC and PGAC besides AASHTO M 320. Reportedly, the test properties from RAC provided significant correlation with transverse and excessive cracking in the field as compared to PGAC. To further validate the precision and accuracy of various testing properties, MTO commenced RAC correlation proficiency program on plant-produced mixes, and numerous laboratories participated in the correlation program in order to (1) enable the individual laboratories to improve consistency and confidence in the test results, (2) equipment calibration for obtaining verifiable data from the laboratories, and (3) understanding the inter-laboratory variability of several parameters pertaining to the performance testing of asphalt cement. In this work, rheological performance and fracture properties of RAC are compared with PGAC based on five years data from correlation proficiency program. To account for rutting, fatigue and thermal cracking distresses, various quality and durability attributes of asphalt cement are evaluated by measuring (1) limiting high temperature Superpave performance grade (XX) and low temperature performance grade (YY), (2) limiting intermediate performance grade (II) where G*sinδ is limited to maximum 5.0 MPa, (3) critical tip opening displacement (CTOD), (4) low temperature limiting grade (LTLG) and grade loss, (5) crossover temperature and low temperature critical spread (ΔTc) etc. Overall, this work demonstrates the testing properties that are sensitive to differentiate the performance and quality of asphalt cement by comparing

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	RAC and PGAC results, thereby promoting the usage of superior quality asphalt for pavements in Ontario and across North America.
Understanding the Impacts of Glassy Modulus Assumptions in Single-Point Rheological Index Determinations **Main Author:** Wes Cooper **Other Authors:** Geoff Rowe	In recent years, a growing appetite for more sustainable asphalt pavements has highlighted the need for better durability measures in the laboratory. Compared to predecessors, binder grading specifications such as AASHTO M 320 have offered methodological improvements in binder characterization by considering diverse climates and asphalt aging. However, a gap remains pertaining to effective characterization of binder relaxation thought to be related to non-load associated cracking. In turn, user agencies are attempting to navigate a broad spectrum of relaxation measures being considered in national research initiatives in order to fill this binder durability gap and promote more longer-lasting pavements. This paper focuses three common binder relation parameters pervasive in the literature but not currently implemented by user agencies in North America: crossover modulus (Gc), single-point Rheological Index (R-Value) measurements, and phase angle at a constant shear modulus of 10 MPa (δG^*=10 MPa). In the study, analysis of 18 non-polymer modified binders from a variety of sources has produced updated estimates of glassy modulus (Gg) using two differing methods to be compared to the assumed value of 1 GPa in shear (or 3 GPa in flexural creep) used in much of the literature. Discussion centers around these new Gg estimates and the associated crossover moduli, from which adjusted R-values are calculated and compared to those made with the previously assumed values to determine impact, trends and relationships. Three potential pathways emerge from the data: consideration of single-point R-value determinations made in dynamic shear (Dynamic Shear Rheometer) or flexural creep (Bending Beam Rheometer) using an updated Gg assumption; bypassing R-values based on Gg assumptions by the use of only Gc, and; consideration of an alternative phase angle parameter that may supply the same data in a more consistent and broadly applicable manner.

Title and Author(s)	Abstract
Preliminary Material Insights from Multi-Year State-Level Pavement Friction Data **Main Author:** Stephen N. Goodman, Ph.D., P.Eng. **Other Authors:** Ryland Potter	As a proven, cross-cutting safety countermeasure for reducing the frequency and severity of vehicle crashes, Pavement Friction Management (PFM) provides road agencies with a powerful tool for balancing the existing roadway friction (i.e. supply) with that required by vehicles to navigate various geometric features (i.e. demand) across their entire road network. Between 2020 and 2024, the Kentucky Transportation Cabinet (KYTC) embarked on an ambitious network-level effort to collect 15,000 miles of continuous pavement friction and texture data annually on state-maintained roads with the ultimate goal of reducing injuries and fatalities. Not only did this effort provide a baseline of existing pavement friction at high resolution, but also collected replicate data on all pavement sections either annually on high-volume roads or bi-annually on lower-volume roads. This unprecedented data collection effort is ongoing, as are efforts to characterize network performance from the resulting friction dataset. With a focus upon material performance in service, this paper will present the preliminary insights uncovered through analysis of thousands of miles (kilometres) of continuous pavement friction and texture data, including the influence of material selection and composition such as aggregate properties, asphalt cement grades, and the incorporation of Reclaimed Asphalt Pavement (RAP) to name a few. Many insights reinforce conventional wisdom although some challenge conventional thinking with respect to mixture composition and ultimately agency specifications. Challenges associated with data management at the network-scale, project-level data input quality, and data aggregation and clustering will also be briefly discussed along with recommendations for deeper data analyses.
Performance and Cost Benefits of Seal Coat Treatments: British Columbia Perspective **Main Author:** Vipin Sharma **Other Authors:** Art Johnston, Dandi Zhao, Beau Annunziello	Various pavement preservation treatments are used by transportation agencies to preserve / extend the service life of the pavements. These treatments have been widely used as a cost-effective method for pavement preservation and maintenance in Canada. British Columbia Ministry of Transportation and Transit use Seal Coat Treatments in the Southern Interior and Norther Regions of the Province to preserve the highway network. As part of this study, performance of several select seal coat projects completed within the last 10 years or so were evaluated for the performance and associated cost benefits. Pavement surface condition at various stages of the pavement life cycle (prior to the application of the seal coat, improvement in pavement surface condition post seal coat application, deterioration in pavement condition during service life and pavement surface condition just prior to the next rehabilitation (where completed)) were analyzed. Similarly, Life Cycle Cost Analysis was also completed for each of the selected project to determine the cost benefits realized from the application of the seal coat compared to the conventional rehabilitation options (such as Mill and Inlay or Overlay).

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	From the review of the analyzed data, ideal time for the application of the seal coat (in terms of exhibited distresses and overall pavement surface condition) and reduction in total cost over the analysis period of about 30% were calculated. This study reiterates the value provided by seal coat treatments in improving the pavement performance and extending the service life as a sustainable and cost-effective strategy for pavement maintenance with significant cost savings provided that they are constructed at the right time.
Evaluating Warm Mix Asphalt and Hot Mix Asphalt: Environmental and Performance Insights **Main Author:** Jason Bausano **Other Authors:** Katrina Mangiaracina and Richard Steger	This case study examines the performance, environmental impact, and sustainability of three asphalt mixtures: a conventional Hot Mix Asphalt (HMA) produced at 330°F, an HMA incorporating 1% hydrated lime at 320°F, and a Warm Mix Asphalt (WMA) utilizing a water-free chemical additive at a reduced temperature of 260°F. The study aims to provide a comprehensive analysis by monitoring key parameters throughout the asphalt production and construction phases. Temperature data was systematically recorded at various stages, including the asphalt plant, load out, during transportation in trucks, at the paver, and throughout the compaction process. Additionally, particulate emissions were closely monitored to evaluate the environmental benefits associated with temperature reductions. Fuel consumption at the plant was also tracked to quantify the potential savings achieved by operating at lower temperatures. Quality control was ensured by collecting mixture samples for rigorous testing. These samples underwent Hamburg Wheel Tracker and Ideal Cracking Test (IDEAL CT) to assess rutting and cracking resistance. Furthermore, the Asphalt Mixture Performance Tester (AMPT) was employed to characterize the dynamic modulus and cyclic fatigue properties of each mixture, contributing to a detailed understanding of their mechanical performance. To assess the sustainability of each mixture, Environmental Product Declarations (EPDs) were utilized to perform a life cycle assessment (LCA) from both cradle-to-gate and cradle-to-grave perspectives. This analysis aimed to provide a transparent evaluation of the environmental impacts associated with each mixture, offering insights into their long-term sustainability. This study seeks to deliver valuable findings on the performance, economic viability, and environmental benefits of incorporating hydrated lime and warm mix additives, thereby contributing to the optimization of asphalt pavement design and construction practices.

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Characterization of Asphalt Mixture Stiffness Using the Impact Resonance Test: Influence of RAP Content and Aggregate Gradation **Main Author:** Jean-Claude Carret **Other Authors:** Jean-Claude Carret, Kevin Bilodeau	The characterization of asphalt mixtures (AM) is critical to ensuring the performance and longevity of pavements under diverse traffic and environmental conditions. Accurate evaluation of stiffness properties is particularly important, as stiffness is a key indicator of an asphalt mixture's ability to resist deformation and cracking and it is also a crucial input for mechanistic-empirical pavement design. This research investigates the application of the Impact Resonance Test (IRT) as a non-destructive method for characterizing the stiffness of asphalt mixtures. Specifically, the study focuses on assessing the influence of Reclaimed Asphalt Pavement (RAP) content and aggregate gradation on AM stiffness. The IRT is a well-established technique commonly employed to determine the dynamic modulus and other elastic properties of cementitious materials. Its adaptation to AM presents an opportunity to obtain reliable stiffness measurements without the need for complex or time-consuming laboratory procedures. The test involves subjecting AM specimens to an impact excitation and analyzing the resulting resonance frequencies to derive stiffness-related properties. In this study, a comprehensive experimental program was conducted using both laboratory-mixed and plant-produced AM. A range of RAP contents up to 30% and different aggregate gradations were considered to evaluate their respective impacts on stiffness. Disc specimens were prepared by sawing in two half shear-gyratory compacted specimens. The IRT was then applied to each specimen, and the fundamental resonant frequencies were recorded and analyzed to calculate the dynamic modulus. The results revealed a clear relationship between RAP content and AM stiffness. As anticipated, increasing RAP content led to a notable increase in stiffness, attributed to the aged binder present in the RAP. The influence of aggregate gradation was less significant. Additionally, the comparison between laboratory-mixed and plant-produced materials highlighted the importance of production conditions on stiffness measurements. While both sets of materials exhibited similar trends concerning RAP content, the plant-produced mixtures generally exhibited slightly different stiffness values than the laboratory-mixed mixtures. This discrepancy is likely due to variations in mixing temperatures and compaction during plant production, emphasizing the need to account for production methods when interpreting stiffness data. The study demonstrates that IRT is a reliable and efficient tool for evaluating AM stiffness, offering practical advantages for both research and quality control applications. The method's non-destructive nature allows for rapid assessment of multiple samples, facilitating the optimization of AM designs without compromising specimen integrity. These findings provide valuable insights into the mechanical behavior of AM containing RAP and different gradations, assisting practitioners in designing more durable and resilient pavements. Future research could expand on this work by exploring the applicability of IRT under varying temperature conditions and investigating

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	the long-term performance implications of RAP content and gradation on pavement durability. This research contributes to the growing body of knowledge on AM characterization and supports the ongoing pursuit of sustainable and high-performance paving solutions. The results will be of particular interest to engineers, researchers, and practitioners seeking to enhance the design and evaluation of asphalt materials through innovative testing methodologies such as the Impact Resonance Test.
Decarbonizing Efforts for Asphalt in Ontario **Main Author:** Doubra C. Ambaiowei **Other Authors:** Jieying J. Zhang, and Jessica C. Achebe	This paper delves into the foundational discussions that have shaped the sustainability strategies and responses of the road-building industry in Ontario, with a specific emphasis on the decarbonization of asphalt. It illuminates the collaborative endeavors that have taken place among key organizations, including the Ontario Road Builders' Association (ORBA), the Ontario Asphalt Pavement Council (OAPC – A Council of ORBA), and the National Research Council Canada (NRC). These partnerships are pivotal in driving large-scale decarbonization initiatives that address the pressing environmental challenges within the construction sector. Furthermore, this paper is intended to serve as a precursor to future scholarly endeavors emerging from our ongoing Life Cycle Assessment (LCA) and Environmental Product Declaration (EPD) Benchmarking study. By synthesizing our preliminary findings and insights, we aim to inspire coordinated actions across the province and provide a strategic roadmap for various stakeholders involved in the industry. In addition, we explore the potential for a partnership to develop a Canadian EPD calculator; similar to the Eco-Emerald label software developed by the National Asphalt Pavement Association (NAPA). Such innovative tools enhance transparency in the asphalt sector, empowering stakeholders to make informed decisions based on accurate environmental data. Ultimately, this paper seeks to make a meaningful contribution to the ongoing discourse surrounding sustainable practices in the construction and road-building field, paving the way for a more environmentally responsible future.
Effect of Bio-Oil on Performance and Aging Characteristics of SBS-Modified Asphalts **Main Author:**	It is well known that the use of polymer modified asphalts is the superior choice for the construction of high-quality pavements. The leading commercial modification technology relies chiefly on thermoplastic elastomers based on styrene and butadiene, which are crosslinked with a small amount of sulfur. This method creates a kinetically stable polymer network that significantly enhances performance at high service temperatures. Although improved, the effect of polymer modification at intermediate and low service temperatures is generally milder. Another approach for the formulation of asphalts for low service temperatures considers the combination of polymer and low temperature extenders. Particularly, the potential use of bio-oils in polymer modified asphalts may result in improved performance while providing a sustainable

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Martin Jasso **Other Authors:** Darren Anweiler, Brett Lambden	alternative to traditional crude oil based asphalt extenders. It is expected that the effect of the bio-oil might improve the resistance to cracking as well as other distresses associated with cold climates. Besides the advantages mentioned, there are also several challenges that are associated with polymer modified asphalts containing bio-oils. The first one is their availability, chemical composition and their compatibility with the colloidal structure of asphalt and the potential interaction with polymer. The presence of bio-oil could result in higher susceptibility of asphalts to oxidative ageing. Additionally, the presence of bio-oils in paving mixes could negatively affect the resistance to moisture induced damage. In this study, the effect of different concentrations of bio-oil on asphalts modified with styrene-butadiene-styrene (SBS) was investigated. Two straight-run asphalts, one with a low penetration value and the other with a high penetration value, were modified with 3 wt.% SBS and crosslinked with a small amount of sulfur. The bio-oil content was optimized for both modified asphalts to meet the PG 58-37P. The bio-oil content was optimized for both modified asphalts to meet the PG 58-37P specifications. The performance of these bio-oil modified asphalts was then compared with that of the reference modified asphalt with PG 58-37P, which contained 3 wt.% SBS and was crosslinked with a small amount of sulfur, but without the addition of bio-oil. The master curves of dynamic material functions in all stages of ageing were constructed. The chemical changes upon ageing were evaluated via Fourier Transform Infrared Spectroscopy. The changes in the colloidal system were evaluated via phase angle at constant modulus. A propensity to cracking was evaluated via Bending Beam Rheometer, Direct Tension, Extended BBR as well as by evaluating the relaxation properties via the Glover-Rowe parameter and crossover frequency. The addition of bio-oil to modified asphalt may play a pivotal role in more sustainable and cost-effective pavements for colder climates. From this perspective, understanding its effects on performance and changes of the aging characteristics and optimizing its potential as an alternative to conventional petroleum-based softening products is essential.

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Maximizing Performance and Sustainability in Warm Mix Asphalt: A Comprehensive Evaluation of Chemical Additives **Main Author:** Maede Mottaghi **Other Authors:** Corey Christian, Pouya Teymourpour	Warm mix asphalt (WMA) technologies have gained widespread attention due to their significant environmental, operational, and economic advantages. By enabling asphalt production and compaction at lower temperatures, WMA reduces energy consumption, minimizes emissions, and enhances workability, offering a sustainable alternative to traditional hot mix asphalt (HMA). Additionally, WMA enables extended paving seasons, improved worker safety, and increased haul distances without compromising pavement performance. This study evaluates the effects of five chemical WMA additives on the rheological and mechanical performance of asphalt binders and mixtures. A laboratory study was conducted using two aggregate types (granite and limestone) and two asphalt binder sources to assess compactability, moisture damage susceptibility, workability, rutting resistance, and intermediate-temperature cracking resistance of the laboratory-prepared WMA mixtures. Furthermore, rheological characterization of asphalt binders was performed to assess cracking sensitivity of the WMA binders using the Glover-Rowe parameter through dynamic shear rheometer (DSR) and bending beam rheometer (BBR) testing across multiple pressure aging vessel (PAV) aging stages, providing deeper insights into the long-term oxidative aging behavior of WMA-modified binders. Results indicate that all WMA-modified mixtures exhibited increased tensile strength ratio (TSR), highlighting enhanced resistance to moisture damage. Moreover, the incorporation of particular WMA additives also led to notable reductions in compaction efforts, enhancing densification efficiency and ensuring more uniform aggregate-binder coating at lower mixing temperatures. Additionally, these additives improved the intermediate-temperature cracking resistance of asphalt mixtures without significantly impacting rutting susceptibility. The RHEA software analysis further confirmed that WMA-modified binders showed better resistance to block cracking across all PAV aging stages, further validating their role in mitigating long term aging-related distresses. Overall, the results underscore the potential of WMA chemical additives as a viable strategy to improve pavement durability while meeting sustainability and cost-efficiency goals. WMA technologies continue to advance the industry's pursuit of resilient, high-performance asphalt mixtures by enabling reduced-temperature production without compromising mechanical performance and integrity, positioning them as a valuable option for advancing sustainable road infrastructure development.

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Cost-Effectiveness Analysis of Long-Life Pavement Design Options: A Case Study of Alberta Highway 58 for Alberta Transportation and Economic Corridors **Main Author:** Cong Luo **Other Authors:** Tony Dhitivara	It is well known that perpetual pavements typically offer economic benefits for high-volume roadways by providing a durable, safe, and smooth surface, while reducing the need for expensive, time-consuming, and traffic-disrupting major repairs or reconstruction. Our analysis of rural applications shows that long-life pavements can also deliver cost-effective performance over their extended service life, presenting a viable solution for sustainable infrastructure development. This study presents a comprehensive analysis of alternative pavement design strategies for Alberta Transportation and Economic Corridors (TEC), focusing on the economic viability of long-life designs compared to conventional 20-year design life for new pavement construction. Based on a case study of Alberta Highway 58, the research evaluates the cost-effectiveness of 40-year and 50-year long-life pavement design options against traditional 20-year designs under various borrowing cost scenarios through a 60-year analysis period. Our life cycle cost analysis (LCCA) framework assesses the long-term economic implications of each design alternative, considering initial construction costs, rehabilitation schedules, and end-of-life values. The analysis specifically examines major rehabilitation events for both conventional and long-life pavement designs, with structural strengthening treatments applied near the end of design life. For long-life pavements, only surface rejuvenation treatments such as mill and inlay operations were considered within the design life. The LCCA results indicate that long-life pavement designs have slightly lower net present value comparing to 20-year design despite higher initial costs. Consequently, this research provides valuable insights for transportation agencies considering the implementation of long-life pavement designs, offering evidence-based recommendations for strategic infrastructure investment decisions in their transportation network. Keywords: Long-life pavement, perpetual pavement, Life Cycle Cost Analysis, pavement design, rehabilitation

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Advancing Sustainable Road Construction: High Reclaimed Asphalt Pavement (RAP) Utilization in Asphalt Layers **Main Author:** Negar Tavafzadeh **Other Authors:** Tony Dhitivara	As the demand for sustainable infrastructure development grows, the construction industry faces increasing pressure to adopt environmentally friendly practices. One such approach is the use of high Reclaimed Asphalt Pavement (RAP) content in asphalt layers, which significantly reduces the consumption of virgin materials and minimizes environmental impacts. This paper presents findings from a test road project conducted in Richmond, British Columbia, where high RAP asphalt mixtures were evaluated for their performance and durability. The primary objective of this study was to assess the viability of incorporating 40% RAP content in asphalt layers without compromising pavement performance. The study involved a mixed design review, visiting the asphalt plant, quality control during the construction of a Trial Road Section, and traffic evaluation, followed by a visual condition assessment. The assessment was completed right after construction, along with the fourth and fifth years after construction. It included confirmation of distress extent and severity and identification of any previous maintenance treatments. Inspectors also noted any traffic or drainage conditions requiring consideration or further investigation. Areas of extensive cracking were further investigated during the field reconnaissance to identify the possible causes of defects. The assessment was completed in general accordance with ASTM D6433-20 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys. One of the goals of the program was to evaluate the performance of the road against a section with a conventional asphalt mix. As such, the potential of using an adjacent section to compare the distress condition against the Trial Road Section was evaluated. Preliminary results from the test road indicate that high RAP asphalt mixtures can achieve comparable performance compared to conventional asphalt mixtures. Additionally, the use of high RAP content demonstrated a substantial reduction in virgin resource consumption, aligning with the goals of sustainable construction practices. This study also highlights the importance of quality control measures during production and placement to ensure consistent and reliable pavement performance. The successful implementation and the lessons learnt of this high RAP initiative in Richmond, BC, serve as a model for other municipalities and transportation agencies seeking to adopt more sustainable paving solutions. In conclusion, the findings from this study highlights the potential of high RAP utilization as a sustainable solution for asphalt paving. This study provides practical insights into the design, construction, and performance evaluation of high RAP asphalt mixtures. Continued research and field monitoring is recommended to further validate long-term performance and optimize mix designs for diverse applications.
Correlation between Air Void Parameters and Properties of AC	Asphalt concrete (AC) mixtures are exposed to extreme weather conditions in cold regions. To understand the influence of freeze-thaw (F-T) cycles on AC mixtures, X-ray CT scan was employed to capture the internal structure of

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Mixtures After Freeze-Thaw Cycling **Main Author:** Haithem Soliman **Other Authors:** Mai Alawneh	different AC mixtures before and after exposure to F-T conditions. A statistical analysis was conducted to investigate the correlation between the changes in the structure of air voids due to F-T cycling and the properties of the tested AC mixtures. The air voids parameters that were considered in the statistical analysis were based on the total area of air voids, average size of a single air void, total number of air voids, and the distribution of air voids over the cross-section of the tested samples. The objective of this statistical analysis was to have a better understanding of how the properties of AC mixtures affect their F-T durability, in terms of changes in the air voids. The finding of this study can enhance the understanding of the F-T damage mechanism in the AC mixtures and help designers optimize the selection of materials and mixture design guidelines in cold regions.
Five Year Field Performance of Cold Recycling Test Sections in a Cold Climate **Main Author:** Jenna Bowers **Other Authors:** Michael Vrtis, Eddie Johnson, Jacob Calvert	In 2019, several cold recycling test sections were constructed on a local road near the Minnesota Road Research Facility (MnROAD) in Albertville, MN, as part of a partnership between industry, the Minnesota Department of Transportation, and the National Center for Asphalt Technology. The selected roadway, 70th Street, was chosen due to its heavily distressed pavement conditions, the cooperation of the roadway owners (the cities of Albertville and Otsego), and its proximity to MnROAD, which enabled routine monitoring using MnROAD's data collection equipment. This location experiences a mix of residential and heavy commercial traffic from a nearby ready-mix concrete plant. Additionally, a MnROAD weather station near 70th Street records ambient weather conditions every 15 minutes, capturing temperatures ranging from 100°F (38°C) to -29°F (-34°C) throughout the year. The project was divided into 500-foot test sections to evaluate the effectiveness of recycling treatments compared to more conventional alternatives. These test sections included cold in-place recycling (CIR) and cold central plant recycling (CCPR), with variations using foamed asphalt with cement and emulsified asphalt without cement. All test sections on 70th Street were overlaid with one inch of hot mix asphalt (HMA). A standard three-inch mill and fill application with the same one-inch overlay served as the control section. Additionally, some sections received no pre-milling and only a one-inch overlay. Since the construction of these test sections, MnROAD has consistently collected data on cracking, rutting, and the International Roughness Index (IRI) several times a year. After five years, the control section with only an overlay has exhibited significant reflective cracking; however, the IRI remains improved compared to pre-construction conditions. The recycled test sections have experienced some cracking but, overall, remain in satisfactory condition. At this stage, the performance differences among the technologies studied are beginning to emerge. This dataset provides a unique opportunity to assess the field performance of these sustainable solutions in comparison to traditional treatments, as well as

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	to gain insights into the effectiveness of different stabilization methods (foam versus emulsion) within a given recycling application (CIR or CCPR).
Performance Comparison Between the French and Superpave Asphalt Mixes **Main Author:** Arash Ghahremani **Other Authors:** Jean-Martin Croteau	The Marshall Method of Mix Design, created in the United States during the 1940s and 1950s, has had a significant impact on the asphalt paving industry in North America and has influenced numerous other regions around the globe. The method was standardized by the American Society of Testing and Materials in 1958 as ASTM D-1558 and it is still used by many road agencies in the US, Canada and abroad. In the early 60s' France was forced to abandon the Marshall approach and engineer a new mix-design method. The trucking context in France after the second world war differed significantly from North America and other countries in Europe. First, the maximum legal axial load was standardized at 13 tonnes, several tonnes heavier than their counterpart in other countries, and secondly, the usage of radial tires, invented by André Michelin in the 40s', completely supplanted the use of bias-ply tires by the end of the 50s'. The combination of heavy axial loads and point-like loads led to widespread rutting in France, to the extent that low-cost asphalt pavement became unsuitable for heavy traffic. A similar context occurred in the 80s' in North America with usage of radial tires also gaining popularities thus, leading to rutting. In 1987, Strategic Highway Research Program (SHRP) was established by the U.S. to develop new materials and methods for the highways. Superpave was one of the major products of SHRP. By the mid-1990s, Superpave was implemented by various highway agencies across North America, leading to standardized practices and procedures for asphalt material design. Since its inception, the Superpave has undergone continuous refinement based on research and field performance data, leading to updates in guidelines and practices. Recently, the North American approach for asphalt material engineering is moving towards a balanced approach to optimize both resistance to rutting as well as resistance to cracking as complementary performance testing to the Superpave approach. Although the evolution of trucking context, and their impact on asphalt pavement in France and North America, were similar despite a two-decade gap, the solutions to address the rutting issue vary between the two regions. This paper investigates the similarities as well as the differences in the asphalt material engineering between the two asphalt pavement mix-design approaches. To eliminate bias related to materials, all mixtures are designed with the same binder and the same aggregates sourced from a single location. The French approach mixtures are formulated as per the standardized French mix-design procedure, while the Superpave mixtures are design using the Ontario Superpave mix-design procedure. Results from advance performance testing from both, France and North America are compared. Furthermore, from the advance performance testing, pavement designs using the French

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	pavement design standard NF P 98-086 and the AASHTO method Pavement Mechanistic-Empirical Design level 1 are compared. By comparing mixtures laboratory performance and structural pavement designs, this study provides critical insights into the strengths and limitations of each mix-design methodology.
Ontario Ministry of Transportation's Experience with Aramid Fibre Reinforced Asphalt Pavements **Main Author:** Heather Bell **Other Authors:** Heather Bell, Gelu Vasiliu, Dariusz Wodala	Between 2016 and 2020, the Ontario Ministry of Transportation (MTO) completed a series of projects to evaluate the impact of aramid fibre reinforcement on the performance of asphalt pavements in terms of reflective cracking, fatigue, and rutting. Each project consisted of test sections containing aramid fibres and control sections without aramid fibres. Two products containing aramid fibres were evaluated: one was a proprietary blend of aramid and polyolefin fibres; and the other consisted of wax coated aramid fibres. At the asphalt plant, pre-measured quantities of the products were added to the pugmill in bags or as loose fibres manually or using a pneumatic system; or in bags directly on the conveyor belt. The cracking and rutting resistance of the plant produced lab compacted control and aramid fibre reinforced asphalt mixtures was evaluated using a laboratory testing protocol that included: • Flexibility Index Test (FIT) using the Semi-Circular Bend (SCB) geometry • Disk-Shaped Compact Tension (DC(T)) test • Hamburg Wheel-Tracking test In addition, MTO's Automated Road Analyzer (ARAN) was used to evaluate the field performance of the test sections after three to seven years, with a focus on Pavement Condition Index (PCI), International Roughness Index (IRI), rut depth, and cracking density. This paper will detail MTO's history with several other types of fibres used to reinforce pavements and the more recent experience of using aramid fibre reinforcement. It will also provide the findings from six projects that incorporated aramid fibres, specifically the laboratory mixture performance tests, field performance, and recommendations on the future use of aramid fibre reinforcement in asphalt mixtures on MTO highways.

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Balancing Performance and Practicality: Implementing Balanced Mix Design in Everyday Asphalt Contracts **Main Author:** Yashar Azimi Alamdary, PhD, P.Eng. **Other Authors:** Sina Varamini, PhD, P.Eng	The research and implementation of performance-based asphalt mixture testing in mix design have gained significant momentum over the past five years in Ontario and across parts of Canada, driving advancements in asphalt mixture durability. A key development in this field is the industry-wide push for the adoption of Balanced Mix Design (BMD), which incorporates both mechanistic and index-based performance testing to enhance durability and sustainability. While many of these tests adhere to ASTM and AASHTO standards, several critical gaps remain in their practical application, particularly for contractual acceptance at a network level—such as in Ontario. These challenges include sample preparation methods, specimen dimensions, compaction techniques, performance testing variability, and material source sensitivity. This paper provides a synthesis of major procedures and protocols used by national and international transportation agencies for performance testing, with a specific focus on the tests actively considered by the Ministry and municipalities in Ontario. These include the Hamburg Wheel Tracking Test (HWT), Semi-Circular Bending Test (SCB), Disk-Shaped Compact Tension Test (DCT), and IDEAL-CT/RT. An expert review of ASTM and AASHTO procedures is conducted, identifying key considerations for integrating performance testing into mix design, performance verification of plant-produced mixtures (loose or field-compacted), and quality assurance programs. The paper also emphasizes strategies for successful implementation, ensuring test reliability and repeatability in real-world applications. Furthermore, this study evaluates the impact of variables such as air void content, thickness variations, coring and cutting techniques, and differences between gyratory and slab compaction on test accuracy. Drawing from an extensive literature review and the authors' industry experience, this paper presents real-world Ontario case studies, challenges, and best practices in BMD adoption using HWT, SCB, and DCT. The discussion extends to the proper implementation of BMD as a pathway toward a performance-based approach, aligning with Buy Clean policies and supported by Environmental Product Declarations (EPDs). Finally, this paper provides practical recommendations for highway agencies, municipalities, and industry stakeholders, offering a structured roadmap for the effective implementation of performance-based specifications. By synthesizing diverse research insights and field experiences, this study aims to enhance asphalt mix performance, improve cost-effectiveness, and contribute to the development of resilient, sustainable infrastructure.
Rubber Modified Asphalt: Performance, Sustainability, and a Roadmap for Implementation	Over the past 25 years, Rubber Modified Asphalt (RMA) has emerged as one of the leading innovations in sustainable asphalt technology, offering enhanced durability and environmental benefits while improving conventional asphalt binders. This paper examines its evolution through laboratory research and field applications, drawing from extensive literature from Canada and the U.S. It explores the material's adaptability to various climatic conditions, with a particular emphasis on its performance in Canada's harsh

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Main Author: Sina Varamini **Other Authors:** Barry H. Takallou**:**	winters. The discussion highlights RMA's pivotal role in the construction industry's efforts to reduce carbon emissions and move toward carbon neutrality through Environmental Product Declarations (EPDs) and low-carbon Life Cycle Assessments (LCAs). Case studies from Canada, the U.S., and Europe are analyzed, along with a roadmap for its efficient production at asphalt terminals or contractor plants and best practices for placement. This study underscores the importance of continuous research and innovation in optimizing RMA's performance and environmental impact, supported by state-of-the-art knowledge and North American industry practices presented in this paper.
Installation and Initial Condition of Innovative Deck Overlay Asphalt Mixture on Princess Margarett Bridge Fredericton New Brunswick **Main Author:** Alain Cormier, P.Eng. **Other Authors:** Michael Esenwa, P.Eng., Anton S. Kucharek, P.Eng. C.Chem., Matthew Sweezie, P.Eng., Ryan Barclay, P.Tech.	Waterproofing systems may vary, depending on the provincial specification, but they generally include a thin, impermeable membrane placed between the bridge deck and the protective riding surface. Other components, such as primer and tack coats, are required to promote proper bonding between the membrane, the bridge deck, and the riding surface, respectively. Together, all these components create a robust waterproofing system whose integrity depends on a minimum level of performance from each component. The innovative bridge deck mixture presented in this paper has waterproofing characteristics and was specifically developed to provide a protective and impervious surface coating, thus preventing the ater ingress, de-icing salts, and other chemicals. Unlike traditional CTAA submissions which can be more research based or technically focused, this paper reviews the details of the work completed on the Princess Margarett Bridge in Fredericton, New Brunswick during the late Spring of 2024, and will focus primarily on the field application and the various stages involved in the waterproofing and paving of this high-profile bridge deck.

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Assessing the unique impact and effectiveness of a post additive to an emulsion for enhancing the properties into a significantly less-tracking tack coat **Main Author:** Michael Jenkins **Other Authors:** Dr. Mikhil Ranka, Ross Marshall	Less-Tracking / Non-Tracking Tack Coats (LNTTC) has grown as a staple in the industry over the last 20 years. During this time, LNTTC has been commonly made with Hard Pen Asphalts. Many Contractors, DOT Agencies, and Universities have been seeking new innovative alternatives over the use of hard pen asphalts. A post additive to an emulsion provides an innovative product that does not rely on HP Asphalt, quick product change in the field, and supports the bond strength needed for roadways. Agencies across the country, like South Carolina DOT, have been measuring the effectiveness of the post additive with road trials and testing and have seen increased improvement, less or no tracking with ease of use. Testing has shown that there is zero change to ASTM or AASHTO test methods. The additive will not change any characteristics for the emulsions T49, T59, & T72 Test Methods. D6930M results for stability with the additive has shown improvement, over 28 days, compared to control. AASHTO M 140 requirements passed all tests during this process. The impact on the enhancement the additive is showing for bond strength, AASHTO TP 114, Interlayer Shear Strength (ISS), increases from the control by 30%. NCHRP 09-64 Project, the tack additive enhanced the ISS, resulting in the finished road product with a tight monolithic layer between the existing and new mix material, less fatigue loss and shifting the failure point of the ISS from the interface to the mix point. The data presented shows the post additive with low dosage rates, can be used with both types of emulsions, anionic or cationic, enhancing bond strength, accelerating dry time, and significantly reducing tracking with ease of use.