Canadian Technical Asphalt Association | CTAA | Association technique canadienne du bitume

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **1**

## Rheology of asphalt emulsions obtained by different evaporation methods

*Martin Jasso, Brett Lambden*

One way to reduce emissions from the petroleum industry and transportation sector could lead through increased application of asphalt emulsions for construction and maintenance of asphalt pavements. Asphalt emulsions have been used in road building and maintenance for almost as long as hot mix technologies, yet there is limited understanding of the performance of these materials. That often leads to pavement distresses such as raveling, bleeding, rutting and thermal cracking and in general in limited load-bearing capacity of roads constructed using asphalt emulsions. These are likely related to structural changes and formation of asphalt film upon breaking of emulsions. The situation could be further complicated by the presence of polymers as emulsions modifiers.
The aim of this work was to study changes of internal structure of asphalt emulsions with and without the presence of polymers upon breaking. The study was performed using complex thermal and thermo-rheological testing in linear and non-linear viscoelastic regions. For this purpose, a wide variety of commercial grades of polymer modified emulsions and high-float emulsions - forming a gel-like structure and therefore complex interaction with polymer structures - were formulated. Two methods were used to obtain the emulsion residues: one, high temperature evaporation method, ASTM D6997 at 400°F, the other low temperature evaporation method, AASTHO R78 Procedure B.
The emulsion residues were tested for master curves of dynamic material functions, shear viscosity, start-up of steady shear and creep and recovery experiments that resembled - within certain limitations – the tests performed with polymer modified asphalts for hot mixes.
It was found that the effect of evaporation method played a significant role in rheological behavior of tested emulsions. The emulsion residues obtained via low temperature evaporation method manifested lower values of phase angle, higher values of viscosity, lower values of compliance function and higher values of stress overshoot compared to emulsion residues obtained via high temperature evaporation method. The crucial question will be: what is the state of the emulsion residue film in the pavement? Which method better mimics reality on the pavement?
The behavior of high-float and high-float polymer modified emulsion appeared to be completely different, e.g., increasing values of viscosity at low shear rates and decreasing values of phase angle at high temperatures. Naturally, already complex rheological behavior of high-float emulsion residues became even more complicated with introduction of polymer.

Paper : **2**

## Evaluating In-Place Compaction and Pay Adjustments Using Pavescan RDM

*Chris Barnes, Adam Marlin*

An introduction to ground penetrating radar-based Rolling Density Measurement (RDM) continuous surveys of in-place asphalt concrete compaction is presented along with in-place compaction survey results using the PaveScan RDM system for four hot mix asphalt resurfacing projects completed in Nova Scotia. The PaveScan RDM results are compared versus quality assurance results that are based on relatively sparse number of cores that are sampled from specific areas of the mat. PaveScan RDM surveys enabled mapping in-place compaction over the full lane widths that were surveyed and indicated areas of consistent compaction deficiencies that have not been well characterized through conventional core sampling approaches. A novel approach is presented for developing contract pay adjustments based on the full shoulder-to-shoulder in-place compaction survey results. It is anticipated that adopting this approach would encourage intelligent compaction processes and improvements in joint compaction methods used in construction.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **3**

## Evaluation of a Bio-Oil to Improve the Performance of HMA Incorporating High-RAP

*Vince Aurilio, Hussain Bahia*

It is common knowledge that millions of tonnes of Recycled Asphalt Pavement (RAP) are being generated around the world on an annual basis. In this circular economy, and with the continued emphasis on de-carbonization, RAP continues to be one of the most reused products in America. For instance, a 2018 US survey conducted by NAPA reported that 82.2 million tons of RAP were reused in new hot mix asphalt (HMA) pavements. Several countries now urge or mandate the use of hot mix asphalt (HMA) incorporating higher RAP contents. Also, it is well understood as roadways age, the bitumen oxidizes, changing both physically and chemically, making it stiff and brittle with age. Over the last 15-20 years, it has become very apparent that the contribution of the binder from the RAP in not 100 percent (i.e., the new binder and the RAP binder are completely blended) and may be as low as 60 percent or not considered to be a ?black rock? (i.e., where no blending occurs).

While using softer grade asphalt to mitigate the problem of stiff recycled binders is a possibility, Recycling Agents (RAs) are being used more commonly as they could be more environmentally friendly, sometimes less costly, and are frequently necessary to properly engineer or design high-RAP mixtures. Several types and brands of recycling agents are commercially available, some are petrochemical oils and others are bio-based oils. Ideally, a recycling agent softens the aged bitumen in RAP, restores it functional properties, makes high-RAP mixtures easier to compact, and delivers road performance and durability comparable to mixes with no or low RAP. From a sustainability perspective an effective recycling agent should be environmentally friendly, help lower greenhouse gas emissions and generate a lower carbon footprint during the entire life cycle of pavement. This paper highlights an example of the key characteristics of a bio-oil and presents several case studies to demonstrate its effectiveness in achieving required binder and mixture properties. The results presented provide evidence of laboratory mixture performance and validation by industry experts. A laboratory testing program is presented to validate key performance characteristics in Canada. Lastly, it is envisioned that field trials will be constructed and discussed at the CTAA conference to confirm the laboratory performance.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **4**

## Waterproofing efficiency of the Confederation Bridge after 25 years of services

*Marc Proteau, Amélie Griggio, Donald McGinn*

Road structures such as bridges and viaducts with a concrete deck must be protected from the aggressions of water often loaded with chloride ions due to the use of de-icing salts in winter maintenance. The lifespan of the waterproofing systems and the wearing courses covering them are usually 20 to 25 years compared to the design periods most often of a hundred years for this type of structure. These protection interventions are therefore very important to ensure the life of the structure without resorting to heavy and costly repairs. The high-performance concrete deck of the Confederation Bridge, linking the provinces of New Brunswick and Prince Edward Island, received at the end of its construction in 1997, the application of a multilayers waterproofing system by fully mechanized applications at high speeds. This waterproofing-wearing course system practiced by the Vinci group for more than 35 years, has been evaluated by the National Research Council Canada CNRC, by the British Board of Agreement BBA and has the various French accreditations.

This article reviews the original construction stages as well as the periodic maintenance interventions to date, presents the results of performance monitoring tests of the waterproofing layers with measurements of the vertical gradients in chloride and sodium ion concentrations, measurements of watertightness under high pressures as well as the levels of oxidation of the different layers.

Finally, the description of the validation board for the renewal works of the wearing course scheduled for 2025 is summarized as well as the predictions of the complete life of the waterproofing system.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **5**

## Quality Control of Full Depth Reclamation (FDR): A Case Study

*Eric Lachance-Tremblay, Sébastien Lamothe, Michel Vaillancourt*

Although full-depth reclamation (FDR) with stabilization of pavements has been known for nearly 50 years, the fact remains that this process is not widely used because its potential (many advantages) is underestimated. This is due in particular to the lack of knowledge related to the pavement design and to the absence of quality control techniques on the work site to monitor the evolution of the curing of theses recycled materials.
It is important to note that FDR has many advantages, including a significant reduction in natural resources (aggregates and bitumen) consumption, transportation, waste and greenhouse gas emissions, resulting in short and long-term energy and cost savings.
Currently, in Québec province, there are no standardized methods or tests to control the quality of materials and to monitor curing (moisture and strength) in situ. In this study, it is proposed to evaluate the applicability of tests that are affordable and sufficiently simple and precise (dynamic cone penetrometer and light falling weight deflectometer) for quality control of recycled materials (thicknesses, bearing capacities and variability), while monitoring their curing in the field (volumetric moisture probes) and referring to the usual laboratory tests (grading, modified Proctor, resilient modulus: MR, and California bearing ratio: CBR).
Dynamic cone penetrometer (DCP) is very easy to perform and allow us to know the thicknesses of the layers and the strength of the materials of the pavement (and their variability) by means of the resistance values measured at the tip of the rod (qd). Through correlations, it is possible to calculate the resilient modulus (Mr) and the California bearing ratio (CBR) of materials, characteristics that are useful values for pavement design. However, it is not possible to use the DCP for stabilized materials because their rigidity is too high for it. It is then necessary to use another device such as a lightweight deflectometers (LWD). This device is easy to transport, to use and allows evaluating the surface elastic modulus (ELWD) of the pavement, which makes it possible to follow up on the curing (or strength) of stabilized materials and to help in the decision-making: to wait or to carry out the following step, i.e. the traffic opening or the paving works. ELWD is determined thought a load cell and three sensors measuring the vertical deflection at the surface after the drop of the weight. Overall, this study has shown that DCP and LWD test are very effective to evaluate the characteristics of FDR, but some limitations were found. Some guidelines for using those test are presented.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **6**

## New Asphalt Binder Grade to Mitigate Climate Change Impacts on Canadian Asphalt Pavements

*Surya Teja Swarna, Kamal Hossain*

Climate change is causing significant alterations in Canadian weather patterns, including an increase in the frequency of extreme events, temperature fluctuations, and precipitation variations. These changes result from rising greenhouse gas concentrations in the atmosphere, and they are expected to intensify in the near future. Asphalt pavements are predominantly susceptible to the impacts of climate change, and it is crucial to consider these effects when designing and constructing pavements. Most studies highlighted the impact of climate change and the influence of future climate on binder grade selection. However, there are a few limitations and gaps in these studies. Most studies in the literature (1) relied on one or two climate models to quantify the impact of climate change, (2) considered one pavement structure, one location, or one climatic region, and (3) based on GCMs with a grid of 300 x 300 km. Therefore, this study aims to quantify the impact of climate change on pavement performance and evaluate the effectiveness of various adaptation strategies. Data on pavement materials, traffic, and structural conditions were collected from various sources, including the Newfoundland and Labrador Department of Transportation and Works (NLDTW) and the Long-Term Pavement Performance (LTPP) database. Simultaneously, the climate change data was extracted using a developed python code from Pacific Climate Impacts Consortium (PCIC). All these were used in the Pavement Mechanistic-Empirical Design (PMED) to predict pavement performance under current and future climate scenarios.

On the other hand, a new pavement temperature model named Canadian Pavement Temperature (CPT) Model has been developed to determine the appropriate binder grade for the climate change data. This CPT model was developed explicitly for Canadian climatic conditions, where previous models were limited in accuracy due to geographical differences. Canada has been geographically divided into three clusters with similar average annual air temperature, annual average precipitation, and freezing indexes to generate this new model. Independent pavement temperature equations have been developed to represent the locations within each cluster. The models were generated using a machine learning technique with 9,144 data points collected nationwide. To aid in implementing the CPT model, a software tool called Canadian Asphalt Binder Selection (CABS) tool has been developed to select the most appropriate asphalt binder based on the predicted pavement temperature. These appropriate asphalt binder grades were utilized as adaptation strategies to mitigate the impacts of climate change and extend pavement service life. In conclusion, this study highlights the importance of considering the impacts of climate change on pavement performance and the effectiveness of adaptation strategies in extending the service life of pavements.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **7**

## Evaluation of Cracking Resistance of High-Performance Asphalt Mixes Composed of Asphaltenes Modified Binder and PET Fibers

*Leila Hashemian, Nirob Ahmed, Mohamed Saleh, Taher Baghaee Moghaddam*

In Northern America, asphalt pavements are most commonly found in road networks. The safety of a road network highly influences its overall productivity and efficiency. High-performance asphalt concrete (HPAC) is an innovative paving mixture in the design and construction of high-traffic roads, which has high strength, superior fatigue life, and excellent rutting resistance. Polymer-modified binders are most commonly used in HPAC applications; however, their applications are limited due to the high cost and the high tendency of phase separation in these binders. In refineries, asphaltenes-rich residues, hereinafter referred to as asphaltenes, are considered waste materials of minimal value with no other relevant applications in the industry; yet they have a high production rate. Alternatively, asphaltenes could be incorporated into the modification of asphalt binders because of sustainability and cost efficiency.
In this research, a straight-run asphalt binder with a performance grade (PG) of 70-28 was modified with 12% asphaltenes (by the weight of the binder), and then the modified binder was used for the preparation of HPAC mixes. The impact of the modification on changing the binder PG was investigated, and it was concluded that asphaltenes-modified binders have higher stiffness compared to unmodified binders. To investigate the cracking resistance of modified mixes, indirect tensile asphalt cracking tests (IDEAL-CT) were conducted on both modified and unmodified mixes, and the cracking tolerance index (CT-index) values were determined. In the next step, to improve the cracking resistance of the asphaltenes-modified mixes, the mixes were reinforced with three different lengths of polyethylene terephthalate (PET) fibres (6 mm, 12 mm, and 18 mm). The analysis of the test results shows a comparison between the calculated CT indices of the control unmodified mix, asphaltenes modified mix and modified mixes using different PET lengths.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **8**

## Development of Environmental Product Declarations (EPDs) for pavement materials in Canada

*Alan Carter, Annie Levasseur, Jean-Martin Croteau, Vincent Grosshenny*

In Canada, like almost everywhere else, the selection of the materials and techniques used for pavement construction and rehabilitation is based on the cost and the performance. The environmental impact of that selection is secondary when it?s even considered. This is due to a lack of knowledge regarding the environmental impact and a lack of incentives to take the impact on the environment into account. Without a recognized method to evaluate the environmental impact, this is a very complicated task.
Environmental Product Declarations (EPDs) are documents that provide transparent and comparable information about the environmental performance of a product or service over its life cycle. They are based on a standardized and internationally recognized method known as Life Cycle Assessment (LCA). EPDs can be used by stakeholders such as consumers, regulators, and policymakers to make informed decisions about the sustainability of products and services.
Since asphalt mixes have the potential to impact the environment both during their production and use, their EPDs should be used to support the selection of more sustainable products. In Canada, EPDs for asphalt mixes can be developed using the Canadian Environmental Product Declaration (CEPD) Program, which is a national program that provides guidance on the development and verification of EPDs for construction products. The CEPD Program is based on international standards and is designed to support the use of EPDs in the construction industry in Canada. Since concrete is used in building construction for which LEED is used, EPDs are more common for concrete materials. In Canada, there is currently no national legislation requiring the use of EPDs or sustainability declarations for construction products. Without government regulations, there may be less incentive for manufacturers to invest in the development of EPDs for their products.
In this paper, Life Cycle Assessments for pavement rehabilitation are explained and examples are given with an emphasis on cold pavement recycling. LCA is a useful tool to properly identify which areas need the most work to improve the environmental performance. Examples of Environmental Product Declarations are also shown and an analysis of the impact of their use in pavement contracts is performed. It is important to note that EPDs are, for asphalt mixes, plant-specific and mix-specific, so even if average EPDs are available, there can be big differences based on the procedure used, the material hauling distance, the type of fuel used for the burner and the shape/age of the plant. The development of EPDs for asphalt mixes can encourage manufacturers to improve the sustainability of their products. By understanding the environmental impact of their products, manufacturers can identify areas for improvement and make changes to reduce the environmental impact of their products over their life cycle.

Paper : **9**

## Performance of Binders Extracted from Asphalt Mixes with Very High RAP Content Rejuvenated with Epoxidized Soybean Oil

*Reza Imaninasab, Marc-André Bérubé, Gabriel Orozco, Luis Loria-Salazar, Alan Carter*

This study focuses on the effectiveness of a bio-based rejuvenator on improving the rheological properties of the asphalt binder extracted and recovered from asphalt mixtures with more than 50% RAP. Rejuvenated asphalt mixtures containing four different percentages of RAP were prepared the volumetrics of those mixes were analyzed in the first part of the study. Epoxidized soybean oil (ESO) was used as the rejuvenator. In the second part, the binder from the four mixes were extracted and recovered. Rheological tests on the E&R binders including performance grade (PG), multiple stress creep and recovery (MSCR), and linear amplitude strain (LAS) test were performed to evaluate the effectiveness of the rejuvenator is influenced by RAP content. Results indicate that, from 100% RAP to 73% RAP, there is one grade (6 ˚C) difference in PG, but 73% to 57% does not result in significant change in PG. The resistance to fatigue was not affected a lot overall.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **10**

## A Novel Approach to Increasing Asphalt Cement Content

*Stephen N. Goodman*

A considerable amount of effort has recently been directed toward increased asphalt cement content. Since its original inception in the mid 1990s, the Superior Performing Asphalt Pavements (Superpave?) mix design system has all but eliminated permanent deformation yet concerns regarding cracking and long-term durability remain. How can durability be increased without sacrificing resistance to permanent deformation, also known as rutting, which presents a significant safety risk to the motoring public?Despite consisting of only three primary components, asphaltic concrete (hot, warm, or cold) is a complex material. It acts more elastically at low temperature with viscous (and even plastic) behaviour increasing with temperature. The complexities associated with the material are largely based on the rheological properties of the asphalt cement itself, which are not discussed herein. However, it is also the interaction between the asphalt cement, mineral aggregates, and air voids in the compacted state that ultimately determine field performance.Simplistically, the aggregates can be thought of as the ?bones? of the material, providing structure and resistance against permanent deformation. The asphalt cement is the binder or ?glue? that holds the aggregate skeleton together under loading from heavy traffic and the environment. And finally, the air voids act as a shock absorber, allowing the asphalt cement to expand and contract with changes in temperature and loading without permitting the reorientation of the mineral aggregates. Superpave strives to ensure durability by designing to a minimum Voids in the Mineral Aggregate (VMA), which is simply the sum of the air voids and effective volume of asphalt cement (Vbe). As the mix design air void content is four (4) percent, Superpave does actually attempt to provide a minimum Vbe. The primary issue arises during Quality Assurance (QA) testing for acceptance. In Ontario (and many other provinces), acceptance is based on air voids, asphalt cement content (by mass), and gradation as opposed to Vbe. These acceptance criteria have fairly significant ranges such that actual Vbe is reduced as compared to the job-mix formula. So, while it may be desirable to increase asphalt cement content, a more prudent initial strategy would be to ensure that the mix on the road has the Vbe for which it was designed. This paper will detail an analysis of almost 800 laboratory samples of Hot Mix Asphalt (HMA) taken for QA and Quality Control (QC) purposes between 2019 and 2021 to determine Vbe. Mixes included both 19- and 12.5-millimetre nominal aggregate sizes, using both Superpave and Marshall mix design methods, and produced by nine (9) different HMA suppliers. Overall, the data indicated that the average VMA of the samples was 99 percent of the JMF value, with considerable spread. However, the average asphalt cement content (by mass) was 97.5 percent of the JMF value (again with considerable spread). Although 97.5 percent is close to 100 percent, the asphalt cement content is by mass, not volume so the average sample Vbe was only 93.7 percent of the JMF value. Additional analyses were then conducted to determine whether specific mix types (19 vs. 12.5 millimetre), design systems (Marshall vs. Superpave), and even Contractors were particularly problematic with respect to Vbe. The results of those analyses will be provided in the paper with recommendations for ensuring sufficient asphalt cement in the mix.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **11**

## Laboratory Evaluation of Rheological, Chemical and Compositional Properties of Bitumen Recovered from RAP Mixtures Treated with Seven Different Recycling Additives (RA) with Aging

*Gerald Reinke, Andrew Hanz, Jo E. Sias, Eshan V. Dave, Zheng Wang*

ABSTRACT

The use of recycling or rejuvenating additives (RAs) to produce asphalt mixtures with higher than typical (above 25% to 30%) contents of recycled asphalt material (RAM) has been gaining increased attention. Recent global pressures from many sectors to reduce carbon footprints, including bitumen production and production of bituminous paving mixtures have intensified. What had been interesting and increasing efforts to utilize bioderived additives to enable higher levels of RAM usage is increasing to a level of urgency for user agencies, bituminous paving companies and producers of additives to supply materials that produce not just short term reduction in bitumen aging but enable sufficient reduction in bitumen aging such that bituminous pavements can survive up to ten years without severe degradation. Some previous studies, especially aging studies of aged bitumen containing RA additives have shown that the positive effect RAs have on initial material properties are not maintained as the materials age. This paper presents the results of laboratory rheological and chemical characterization of mixtures containing seven different RA products and three control mixtures. The mixtures were produced and paved in August of 2019 as part of a National Road Research Alliance (NRRA) field research study with a 40% RAP mixture. Test sections using seven different RA additives were paved on Trunk Highway 6 near Emily, Minnesota. Each RA supplier determined the amount of their RA additive that needed to be added to the base binder (PG 58S-28) to produce a PG XX-34 binder that would then be mixed with 40% RAP and placed on their test section. Samples of the virgin PG58S-28, the RA blended binders, and samples of the 40% RAP mixtures produced with each RA additive and the controls were obtained during mix production. Binder rheological, chemical, and compositional characteristics of the as blended binders and bitumen recovered from mixtures were characterized. Further the as blended binders and bitumen recovered from RA mixtures were PAV aged for 20, 40 and 60 hour times. FTIR and Iatroscan tests were performed on all binders at all aging conditions. Data from mixtures at time of production and after years 1 and 2 are compared and presented. Field cores after 3 years in service are in the process of being tested and should be available for a verbal update at the time of the CTAA meeting. The goals of this study are to provide information to the NRRA sponsors how different RA materials perform in direct comparison to the control test sections (no RA added but containing 40% RAP). The evolution and aging of properties of the various RA products are compared with their respective control materials. To preserve confidentiality RA suppliers and specific RA materials are not identified in this paper.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **12**

## Impact of mix design property variability on field performance of asphalt

*Lindsay Johnston, Sheldon Klassen, Luis Vega, Vipin Sharma*

The primary objective of developing laboratory-produced asphalt mix designs is to establish conditions that as best as practicable replicate plant production, field laydown and compaction, and quality control and assurance processes. The ability to replicate these conditions provides confidence that the asphalt mixture will demonstrate similar material qualities in both the laboratory and field and will provide the selected performance characteristics. Recent experience suggests current asphalt mix design processes do not always provide material characteristics correlating to those produced in the field following plant production and laydown. This paper presents the findings of a study investigating laboratory testing variability of key asphalt mix properties and how this variability could influence quality, performance, and overall cost of asphalt production.

A study was undertaken in 10 laboratories across 7 Canadian provinces and territories to compare the potential variability of 5 key metrics employed in asphalt mix design: 1) fine aggregate specific gravity, 2) coarse aggregate specific gravity, 3) Theoretical Maximum Specific Gravity of uncompacted asphalt, 4) bulk specific gravity of compacted asphalt, and 5) addition of dust in the lab to replicate the inadvertent creation of dust by the plant.

The study focused on three key components of each of the five mix design metrics:

1) How test property variation in the lab compares to measured material property in the field.
2) How potential test property variability can influence mix design performance in the field.
3) Potential economic implications of the inherent variability.

Asphalt mix and aggregate from a single source was sent to 10 independent laboratories for evaluation. Outcomes from the study for the five key metrics were compiled and reviewed. A summary of resultant variability is presented with commentary on the potential biases that may exist within a specific test type or testing procedure between independent laboratories.

These performance metrics studied are arguably the most impactful as they are used in the volumetric calculations in quality control and assurance reporting. Combined, these metrics are used to calculate optimal binder content and absorption and represent the strength, flexibility, and durability of the asphalt mix over its intended lifespan. If the laboratory values for these material properties are not representative of field conditions and plant production, it would be unreasonable to expect the overall field performance of the asphalt mix to correlate with the intended properties established for the asphalt mix design.

Testing that accurately represents in-place conditions can result in a more cost-efficient mix design. The balance of an asphalt mix design containing an appropriate amount of asphalt binder is highly dependent on these five metrics. Small variations in asphalt binder content can be the difference between spending too much on asphalt binder or having a ?dry? asphalt mix that can have a shorter life cycle. The results from this study provide an objective evaluation and comparison of potential variability in the outputs from the five key components used for asphalt mix design and their contribution as important factors in monitoring plant production and laydown processes. The influence of these variations on potential performance impacts and economic factors is also investigated.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **13**

## Emissions and Fuel Savings Using WMA at Reduced Asphalt Mixture Production Temperatures

*James Wurst III, Richard Steger, Katrina Mangiaracina, Everett Crews*

Greenhouse gas (GHG) emissions reduction has become an area of increased focus for the asphalt pavement industry over the past decade. Across North America, an effort to calculate the amount of GHG emissions generated to produce an asphalt paving mixture (cradle-to-gate) has become a focal point for numerous agencies. As the asphalt pavement industry looks for means to reduce the carbon footprint of mixture production, the use of Warm Mix Asphalt (WMA) technologies to reduce asphalt mixture production temperatures has been offered as a solution.

While WMA is correctly viewed as a solution to the GHG emissions focus, there is limited data characterizing the reductions in emissions and fuel consumption. During the 2022 paving season, the research team collected emissions and fuel data at seven different asphalt plants across the United States. In this paper, we illustrate the impact of WMA GHG reduction on three key areas: fugitive emissions at the plant and construction site, stack emissions, and burner fuel consumption. The researchers collected these three types of data using a variety of different asphalt plant types, production rates, mixture types, and recycled asphalt pavement (RAP) contents among other variables. Each field project consisted of multiple control hot mix asphalt (HMA) runs compared to data collected over one-hour periods for multiple WMA reduced-temperature runs. The experiments were constructed to create multiple one-hour plant datasets for each different temperature.

Fugitive emissions were a primary data type collected in these projects as a function of mix production temperature and mix temperature during laydown at the construction site. Fugitive emissions are seldom collected on this scale to assess the impact of mix production temperature reduction when using WMA. Using a monitoring device called the APT Minima, fugitive particulate matter emissions were measured for three different particulate sizes:  1.0 microns (PM1.0), 2.5 microns (PM2.5), and 10.0 microns (PM10). With these data, we can quantify the fugitive emissions reductions afforded by decreased mix production temperatures utilizing WMA.
Stack emissions differ from fugitive emissions since stack emissions are generated from the asphalt plant exhaust stack as a result of combustion of the burner fuel by the asphalt plant during asphalt production and as a result of mass transfer of some particulate matter through the baghouse. Asphalt plant stack emissions data were measured at five plant locations across the United State. The data in this paper illustrates the achievable reductions in CO2 and other Primary Pollutants (NOx, VOC, CO, PM) when reducing the asphalt mix production temperatures using WMA.

Along with the emissions data, fuel consumption data were also collected in these projects, and the results illustrated how asphalt plants, operating under realistic production conditions, can reduce the fuel consumed per ton of asphalt mixture. By publishing this data on fuel and emission reductions using WMA, the researchers will assist the asphalt industry?s effort to reduce carbon footprint and GHG emissions while demonstrating a viable methodology for contractors to follow to quantify these reductions for themselves.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **14**

## Long Term Performance of Projects Completed with CIR and FDR in City of Calgary

*Vipin Sharma, Nasir-ul Mulk*

City of Calgary completed pavement rehabilitation using Cold In Place Recycling (CIR) and Full Depth Reclamation (FDR) strategies for several roadway segments between 2002 and 2013. Tetra Tech initially completed assessment of four roadway segments (Center Street, Symmons Valley Road, 144 Avenue NW and Highway 22X) for City of Calgary. While Hwy 22x was rehabilitated in 2002, other roadway segments included in the study were completed between 2011 and 2013.

Evaluation of these projects was completed in 2017 and included review of pavement condition data, visual condition assessment, Road Radar testing, asphalt pavement coring and pavement strength testing using a Falling Weight Deflectometer data. The collected data was analyzed to back calculate the layer coefficients of the FDR and CIR layers.

Section of Hwy 22x has since been reconstructed as part of the Ring Road project. This paper will look at the long-term performance (greater than 10 years) assessment of the roadway segments that were rehabilitated with FDR and CIR. Current evaluation include review and analysis of the current pavement surface condition (visual observations and Laser Crack Measurement System) and FWD data. The deterioration of the pavement surface condition in terms of exhibited distresses, change in strengthening requirements and layer coefficients were calculated and discussed.

Paper : **15**

## Efficient and Effective Specification for Asphalts of Today

*Pavel Kriz, John A. Noel, Christpher M. Campbell, John H. Brownie*

Adequate asphalt binder selection process is essential to well-performing pavement from both economic and environmental stand points. The selection process is typically managed by specification standards valid in a given jurisdiction. The objective of the standard should be to establish fair, predictable and uncomplicated process that every supplier can follow to select adequate binders for construction and exclude those which do not meet selected thresholds for performance. Initially, the key critical parameters for asphalt binders? performance included consistency, temperature and oxidation susceptibility. Later on, other parameters were added to better discriminate performance which included monitoring cracking and relaxation properties, etc. The most recent evolution of asphalt specifications came in the early 1990s, with SuperPave? establishing testing at environmental temperature and introducing a common rheological approach. SuperPave? was robustly validated on refinery asphalts produced at the time and significantly improved the binder selection process.
With alteration of binder composition in recent years, mainly due to use of recycled asphalt pavement, recycling aids, softening oils, extenders, performance additives, etc., SuperPave? has been claimed by some to no longer properly distinguish poorly and well-performing binders. A number of research papers and reports were published, suggesting a plethora of potential solutions. The objective of this paper is to provide a guide to efficient and effective specification process utilizing fundamental and well-established science, to not only distinguish binders based on their performance, but also to make the process sustainable, fair, repeatable and relatively simple.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **16**

## ASSESSING THE PERFORMANCE OF NEW ASPHALT CONCRETE MIX DESIGNS FOR THE PROVINCE OF NEW BRUNSWICK

*Nora Ruiz Salom, Xiomara Sanchez*

In the last few years, the New Brunswick Department of Transportation and Infrastructure has been researching and changing its asphalt concrete guidelines to be up to date with the latest technologies and international standards for their highways and roads. This project provides insight into the modifications and tests on three selected contractors around the province of New Brunswick. These modifications were made only on the mixes gradations following AASHTO Superpave guidelines and specifications. Specifically, the modifications studied and analyzed in this paper consider the effect of the removal of all blending sand and the increase of the percentage of fine aggregates passing the 75-micron sieve. The experimental work reviewed in this paper will evaluate preliminary performance test results for rutting, and cracking distresses for new mix designs compared to the currently approved mix design for these contractors. The Hamburg Wheel Tracking test and The Ideal Cracking Test were the performance tests chosen for assessing rutting and cracking distress, respectively, as each mix design performance will vary according to the quality of the materials and external conditions, such as the expected weather at the road location. A detailed description of the conditioning protocol and testing parameters, including tests? temperatures for the ongoing research, is discussed in the latter part of the paper. This project's outcomes will be helpful to the province of New Brunswick during the update of the asphalt concrete specifications considering volumetric design with performance verification.

Paper : **17**

## Extreme Heat Events: Defining the Critical Scenario for Ontario Flexible Pavements

*Alyssa Bernier, Sina Varamini, Kamal Hossain, Mohammad Shafiee*

The onset of anthropogenic climate change is becoming more evident with each passing year. Hurricanes, floods, windstorms, wildfires, and droughts are among the extreme weather events that, though previously considered rare, are being observed on a yearly basis around the globe. Overall increasing ambient air temperatures are a more subtle, but definitely noticeable consequence of the warming planet. Northern regions are predicted to be among the first to observe significant rises in temperatures. This has been observed recently in Canada through summer heat waves which have reached unprecedented temperatures in regions that are typically quite temperate. Understanding these types of extreme heat events is critical to better preparing and adapting for the onset of climate change. To date, all available heat wave definitions have been based on human health indicators and comfort levels. However, many industries will experience adverse effects due to extreme heat that may commence at a different time than the human health effects. Flexible pavements have been found to be vulnerable in the face of extreme heats due to the temperature sensitivity of asphalt binders. This study attempts to address this gap by proposing temperature thresholds to define heat waves from a flexible pavement performance perspective. Three pavement sections are selected to represent each of Ontario?s asphalt binder grade zones. Hypothetical heat wave scenarios are created to reach increasingly extreme temperatures for an increasing number of consecutive days. The pavement performance for each of these sections under the various heat wave scenarios is predicted using AASHTOWare Pavement Mechanistic Empirical Design software. A sensitivity analysis is performed on the predicted rutting under each scenario to identify the critical combination of air temperature and duration for each of the relevant asphalt binder grades. The results of the sensitivity analysis are used to propose a heat wave threshold for each zone from a flexible pavement perspective. Wherever applicable, other predicted pavement distresses are also considered. The results of the study may allow stakeholders to better identify when a heat wave may threaten pavement performance and administer mitigation and adaptation measures accordingly.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **18**

## Lessons Learned from Ontario Mix Asphalt Program ? A Critical Look at Hamburg Wheel Tracking Test

*Doubra Ambaiowei, Sina Varamini, Pejoohan Tavassoti-Kheiry, Selena Lavorato, and Yashar Alamdary*

Research efforts are being undertaken in North America, particularly Canada, to improve methodology for designing asphalt mixes, in order to incorporate laboratory tests and procedures into material specifications. Some of these efforts have further demonstrated that implementing performance tests can improve the longevity of asphalt pavements and reduce risk of early pavement deterioration. The Ontario Asphalt Pavement Council (OAPC ? Council of Ontario Road Builders? Association, ORBA) is particularly interested in this focus, as potential means of addressing any concerns on premature cracking of asphalt mixes. In light of this, the OAETG - Mix Asphalt Program (O-MAP) research study, commissioned by the OAPC, has been conducted to examine any issues and challenges related to the performance of typical Ontario Superpave asphalt mixtures.

Further to the industry?s readiness to identify any issues and challenges involving performance of typical Ontario Superpave asphalt mixtures, this paper summarises findings, recommendations and next steps from two rounds of O-MAP Testing. The study findings indicated that the success of adopting performance testing in Ontario is reliant on the ability of both the owner-agency and industry to establish and meet performance criteria related to test methods including, but not limited to: Hamburg Wheel Tracking Device (HWTD), Semi-circular Bend Test (SCB), and Disk-Shaped Compact Tension (DCT) array of tests. The round-one results were further incorporated into Performance Space Diagram (PSD) to better characterize characteristics of mixes based on performance testing conducted.

For each round plant-produced mixtures were utilized. Round one was more focused on testing variability in terms of interlaboratory and between mixes variability. Throughout the round one, it was found that HWTD has significant variability which could become problemtic in terms of contractual acceptance and risk to owner and contractor. Based on research performed by the OAETG, it was realized that gyratory compactors may have limitations in gyrating relatively thin specimens and potentially causing inherent variability through the process. For this reason, round two was designed to gyrate and cut specimens from different heights to better capture the variability due to sample fabrication and test itself. Based on the identified study limitations and results analyzed and verified by O-MAP?s Oversight Study Team (OST), members of OAETG, there are still areas requiring further investigation in order to better understand the factors that may affect mix properties, testing parameters, testing equipment/fixture differences, or a combination of all these factors, including the effect of changing height on the reliability of Superpave Gyratory Compactors (SGCs) used in the province, and their differences as a significant source of variation related to "within" and/or "interlaboratory" Coefficient of Variation (COV).

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **19**

## Laboratory Performance Benchmarking of Asphalt Airfield Mixtures for Pearson International Airport Using Advanced Methods of Mechanistic Testing

*Sina Varamini, Kevin Chee, Andrew Pahalan, Mazen Fallaha, Salman Bhutta*

Airport runways and taxiways are commonly comprised of a flexible type of pavement surfaced with asphalt mixture that need to endure extreme stresses induced by slow-moving aircraft traffic with stop and go movement, combined with extreme climatic conditions. These mixtures need to exhibit high level of resistant to shoving and rutting, while remaining at high level of flexibility at intermediate and cold temperatures.

This paper provides information on steps employed in designing high stability asphalt mixtures for the busiest airport in Canada, the Toronto Pearson International Airport. The design was completed by considering different aggregate mineralogizes ranging from trap rock, gabbro, diabase combined with highly modified Performance Graded Asphalt Cements of PG 70-28 and 64-28. The design process involved: (1) designing surface and binder course mixes using Superpave volumetric method of design to provide high level of stability, and (2) performance testing to capture the mechanical properties of the mixture compared to a conventional asphalt mixture used at the Pearson airport. Performance testing included advanced indexing type and modulus testing including: (a) rutting performance by using Hamburg Wheel Tracking Test, (2) Semi-Circular Bend Test, (3) Disc-Shaped Compact Tension Test (DCT), (4) Compression-Tension Uniaxial Fatigue test, and (5) dynamic modulus testing and flow.

This paper further explains the applicability of methodology adopted to develop this mix to other airports in Canada, as well as its applicability to perform a resiliency benchmarking against extreme environmental conditions.

Paper : **20**

## 5TH YEAR REVIEW OF INNOVATIVE DECK WATERPROOFING ASPHALT MIXTURE - HILLSBOROUGH BRIDGE, PEI EXPERIENCE

*Michael Esenwa, Anton S. Kucharek, Alain Cormier, Stephen Yeo, Tim Cheverie*

Bridge deck deterioration is one of the major problems affecting the longevity of bridges. Although several factors can contribute to bridge deck distresses, moisture and chloride intrusion are two factors that significantly accelerate deterioration. In Canada, the practice of bridge design and protection against reinforcement corrosion has evolved over the last 50 years to address the ingression of moisture and chlorides while ensuring a minimum level of protection against corrosion by including a waterproofing system.
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.
In Canada, asphalt mixtures have been predominantly used as a protective riding surface when paved over a waterproofing membrane. It has been observed, however, that asphalt overlays on bridge decks often do not last as long as intended. Ravelling, delamination, and potholing are more frequently observed on bridge decks when compared to their adjacent asphalt surfaces.
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 ingression of water, de-icing salts, and other chemicals.
This paper reviews details from conception, design and initial field trials of the work completed on the Hillsborough Bridge on Prince Edward Island, which was paved in the Fall of 2022, and delivers findings on the performance assessment of the very first project that utilized this mix in Brighton, ON, five years after construction.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **21**

## Effect of Extended Oven Conditioning on the Performance of High RAP Asphalt Mixtures Containing Bio-based Rejuvenators

*Hui Liao, Pejoohan Tavassoti, Hassan Baaj*

Utilizing Reclaimed Asphalt Pavements (RAP) for Hot Mix Asphalt (HMA) production has become a routine practice in North America, yielding both environmental and economic benefits. Current maximum allowable RAP content varies from 20 to 30 percent by the weight of asphalt mixtures across different provincial specifications. Concern about the aged asphalt cement in RAP still remains the main reason behind the reluctancy to increase the allowable RAP content by different agencies. Although the relatively higher stiffness of RAP incorporated mixes is beneficial in terms of their rutting resistance, the presence of aged asphalt cement can embrittle asphalt mixtures and potentially increasing their susceptibility to thermal and fatigue cracking. Therefore, adding the optimum amount of asphalt rejuvenators can help maximize the RAP content by revitalizing and softening the aged asphalt cement without impairing their rutting performance. Rejuvenation process is time- and temperature-dependent, where increasing either the time or temperature during the mixing and conditioning can promote the aged binder mobilization and homogenization of the blended asphalt binder. To this end, this paper aims to assess the effect of extended oven conditioning time on the cracking and rutting performance of rejuvenated high RAP mixes. Two bio-based rejuvenators and a soft Performance Grade (PG) asphalt cement (PG 46-34) were selected to prepare the Lab-Mixed Lab-Compacted (LMLC) recycled asphalt mixtures containing 50% RAP. To capture the rejuvenation effect, two control mixes, with 20 percent and 50 percent RAP content, were also prepared using a PG 58-28 virgin asphalt cement. The Hamburg Wheel-Tracking (HWT) test and the Indirect Asphalt Tensile Cracking Test (IDEAL-CT) were conducted on the aforementioned mixes to evaluate their rutting and cracking performance at high and intermediate pavement service temperatures, respectively. In addition to the 4-hour short-term conditioning protocol recommended in AASHTO R30, the loose mixes were also conditioned for 10 hours at 135oC to investigate the impact of extended conditioning time on the performance of rejuvenated asphalt mixes. The results indicate that cracking resistance of the mixes was less sensitive than their rutting resistance to either the increase in RAP content or use of rejuvenators (or soft asphalt cement). After extending the conditioning time from four to ten hours, the rejuvenated high RAP mixes experienced a prominent decrease in the cracking performance indices, indicating a declining trend of cracking resistance. However, the HWT test results showed that extending the conditioning time significantly alleviated the plastic deformation and moisture damage of the asphalt mixes. Nevertheless, the findings of this study suggest that the high RAP mixes with bio-based rejuvenators can achieve improved rutting and moisture resistance and similar cracking resistance compared to the mix with less RAP content by properly conditioning the mixes in a high-temperature environment, similar to the process that occurs during the silo storage of loose asphalt mixes.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **22**

## High RAP Mixtures in Alberta

*Arash Ghahremani, Wayne Mah*

The utilization of reclaimed asphalt pavement (RAP) in asphalt mixtures is driven by both economic considerations and environmental benefits. To promote sustainable and cost-efficient solutions, agencies and the industry continuously work to increase RAP recycling.

The primary challenges in incorporating higher amounts of RAP in hot asphalt mixes is ensuring that a mix design effectively addresses the negative effects of the stiff and brittle aged binder in RAP on the long-term performance of the mixture, as well as managing the variability of the RAP during production.

Currently, Alberta Transportation is assessing the current specification to determine the feasibility of using more than 30% RAP in hot mix asphalt in a risk-managed way. To this end, two highway sections were rehabilitated as trial projects using 40% RAP in the mixture. This paper presents details on the mix designs strategies employed for high RAP mixtures in these trial projects, including the approach used by the Georgia Department of Transportation (GDOT), which involved reducing RAP binder contribution, decreasing the number of gyrations, and conducting performance-based testing, as well as a mix designed using a rejuvenator. The paper also presents observations from production, paving and quality control.

Paper : **23**

## Evaluation of the Process and Placement of a Residential Slurry Seal Using a Highly Modified Asphalt Emulsion

*Justin Suda, Anton Kucharek, Nathan Prosko, Faizal Kanji*

Surface treatments add valuable road service life to existing road structures by protecting the pavement from oxidation and moisture damage and repairing or preventing minor surface distresses.
In 2020, the city of St. Albert, AB in collaboration with McAsphalt (supplier), and ACP Applied Products (contractor), conducted a field trial using a modified slurry-type emulsion designed to combat early mat deformation. Surface treatments ? such as slurry seals and micro surfacing ? are most vulnerable to deformation immediately after the roadways are re-open to traffic. This is common in residential neighborhoods, as traffic must reopen shortly after application, often before the treatment is completely cured. Distresses such as surface deformation and scuffing caused by stationary steering can accumulate and create more significant pavement defects that will ultimately require repairs, such as patching.
The main objective of the current study is to evaluate if the described surface defects can be reduced or even eliminated by means of using emulsions with higher modification levels, or with different types of polymer modification. The effect of these emulsions in preventing early surface damage is assessed within an ISSA Type I slurry seal system used for this residential area. The paper presents the findings of the field study and makes recommendations for slurry system design, emulsion specifications, and on-site control measures.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **24**

## A Critical Look at the Semi-Circular Bend Test in Promoting Best Mix Performers

*Saeid Salehi Ashani, Sina Varamini, Susan Tighe*

The Semi-Circular Bend (SCB) test has been utilized as a performance-related test to assess the intermediate cracking resistance of asphalt mixes based on several indices derived from the load versus displacement curve of the test. To date, the SCB indices comprise of flexibility index (FI), rate dependent cracking index (RDCI), cracking resistance index (CRI), and balanced cracking index (BCI). Recently, the interaction plot between the FI components, i.e., fracture energy and post peak slope, has been of interest to evaluate the intermediate cracking resistance of asphalt mixes. Generally, the SCB indices can be utilized as a tool to select suitable materials for asphalt mixes, especially new materials with less known field experience and performance, towards a sustainable and resilient asphalt mixture. Not only the SCB indices can be used to ensure the longevity and durability of asphalt mixes, but can be incorporated as a cracking resistance index, accompanied by a rutting resistance index, to develop an engineered or balanced mix design (BMD).

This research had fourth main objectives: Firstly, to determine whether the above-mentioned indices had similar variability and were able to capture the fatigue cracking resistance of asphalt mixes identically. Secondly, to identify whether the indices were sensitive to the testing temperature and oxidative aging. Thirdly, to determine the intermediate temperature performance grade of asphalt mixes obtained from the indices and to compare the intermediate temperature performance grade of asphalt mixes with the intermediate temperature performance grade of their corresponding recovered asphalt binders. Fourthly, the effect of testing temperature and oxidative aging on the FI interaction plot was investigated. In order to fulfill the objectives of this research, five plant-produced SP12.5 surface course asphalt mixes were investigated. The unaged SCB testing specimens were tested at different intermediate temperatures (10, 16, 19, 22, and 25°C), and the oxidative aged specimens were conditioned according to AASHTO R35 test method and were tested at 25°C.

The analysis of the results revealed that FI is not enough to fully capture the asphalt mixes? intermediate cracking resistance. Alternative methods, such as interaction plot and analyzing fracture energies and post peak slopes may be more appropriate to compare and characterize the intermediate temperature cracking resistance of asphalt mixes.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **25**

## Investigating the combined effect of active and inert filler on rheological and mechanical performance of asphalt mastic and asphalt mixture

*Shahrul Ibney Feroz, Ankan Mohajon, Debzani Mitra, SK Faisal Kabir, Kamal Hossain, Yusuf Mehta*

Filler, a fine powder used in asphalt mixture, plays a dual role as an inert filler to fill gaps between mineral aggregates and an active filler to mix with asphalt binder to generate a high-consistency asphalt mastic. This mastic is the main component of an asphalt structure that deforms when stress is applied and may significantly alter the mixture's physical and mechanical properties. Substantial research focused on using either active or inert fillers, whereas only a few research has examined the combined impact of active and inert fillers. This study compares the rheological and mechanical performance of asphalt mastics and asphalt mixtures fabricated by combining active and inert fillers containing modifiers and anti-stripping agents. Multiple Stress Creep Recovery (MSCR) test following AASHTO T 350 was performed to understand the rheological performance of aged asphalt mastic. This investigation used Gilsonite and Styrene-Butadiene-Styrene (SBS) as modifiers to modify the neat PG 58-28 binder and Zycotherm and AD-Here as liquid anti-stripping agents. For fabricating the mastics, different proportions (10%,20%,30% by the weight of base binder) of Hydrated lime (HL) and Fly ash (FA) were selected as active fillers, whereas different proportions (70%,60%,50% by the weight of base binder) of Limestone (LS), Dolomite (DM) and Basalt (BS) were selected as inert filler materials. The active and inert fillers were added in such a way that the Filler Binder (F/B) ratio remains 0.8. Rolling Thin-Film Oven (RTFO) protocol was applied to simulate construction and laying time oxidative aging. The performance of these mastics was compared using non-recoverable creep compliance, stress sensitivity analysis, percent recovery analysis, AASHTO M 332 specifications, and polymer modification curve specified by the Asphalt Institute (AI). Scanning Electron Microscope (SEM), X-ray fluorescence spectroscopy test (XRF), specific gravity (SG) with the pycnometer method, and specific surface area (SSA) with Blaine's air permeability test were carried out to shed light on the physical and chemical properties of the fillers. The Marshall stability and flow test, Indirect Tensile Strength (ITS), and moisture damage evaluation tests were performed for the mechanical properties of the asphalt mixture. Marshall Quotient (MQ), Retained Marshall Stability (RMS), and Tensile Strength Ratio (TSR) were discussed to elucidate the rutting resistance, stiffness, and moisture susceptibility of the mixtures. Finally, an ANOVA analysis was conducted at the mastic level to determine the significant factors to describe the rutting performance of asphalt mastics. Based on the mastic level analysis, the combined effect of HL and LS modified with SBS containing Zycotherm was predominant and satisfied all the rutting and creep recovery performance requirements. However, 25% of mastics failed to pass the percent recovery criteria. Mixture level investigation's findings indicate that combining HL and LS containing SBS and Zycotherm improves asphalt mixture performance while proving to be more cost-effective because the optimal binder percentage is 12% lower than the control mix. Additionally, HL and LS exhibit a stronger affinity for the binder, which is responsible for their significant stiffening effect and acceptable resistance to moisture damage.

# 2023 Paper Abstracts in Tentative Presentation Order

Paper : **26**

## Automated Pavement Condition Evaluation: A Case Study of Delaware Department of Transportation's Implementation of the Pavement Surface Cracking Metric

*Danilo Balzarini, Jason Trotter*

The development of new laser technologies in recent years has revolutionized the way pavement data is collected, enabling a more automated approach to pavement condition evaluation. In this paper, we present the case study of the Delaware Department of Transportation (DelDOT) application of the Pavement Surface Cracking Metric (PSCM), for network pavement condition evaluation. Adhering to the new ASTM E3303 Standard, the PSCM uses quantitative definitions to ensure consistency of the results and eliminate the subjectivity associated with human rating of the pavement distresses. The repeatability and reproducibility of the data collected are analyzed and discussed. The use of PSCM and its complementary metric, the Pavement Surface Cracking Index (PSCI), for year-over-year comparison and data analysis are investigated. Finally, the effectiveness of these metrics in taking informed pavement management decisions is presented.