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

2021 Paper Abstracts in Tentative Presentation Order

Paper : **1**

Aggregate Bulk Specific Gravity: Controlling Asphalt Binder Content of Asphalt Mixtures

Gerry Huber, Christopher Campbell, Matt Beeson, Bill Pine, Jason Wielinski, Gerald Huber

Since the earliest days of asphalt mix design more than 100 years ago the design objective has been to determine the appropriate amount of asphalt binder. The importance of having sufficient asphalt binder for a mixture to have longevity was realized and asphalt mixture volumetrics were developed in the 1920s. It was not until the 1960s that a method was established to quantify the amount of asphalt binder that exists outside the aggregate and specifications were developed to specify the minimum amount required.

Today's specifications for asphalt content are based on a required volume of effective asphalt binder calculated using voids in the mineral aggregate (VMA) and air voids. VMA is calculated using aggregate bulk specific gravity. The process is clearly defined, but implementation has created confusion.

Despite the standardized specifications for mix design, many specifying agencies have chosen other approaches believing they are more correct, more accurate or easier to implement. Such alternate approaches bring unintended consequences that are not well recognized.

This paper will investigate the use of various aggregate specific gravities to calculate VMA, challenges to measuring and using bulk specific gravity, measuring specific gravity of asphalt coated aggregates in reclaimed asphalt pavement and using effective volume of asphalt binder as an acceptance parameter.

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Paper : **2**

A State of the Art Review: Approaches for Assessing the Compatibility of Asphalt Materials and Additives

Runhua Zhang, Eshan V. Dave; Jo E. Sias; Hassan A. Tabatabaee; Tony Sylvester

A major challenge in current asphalt pavement material selection, specification and mix design processes is the lack of a clear process to determine compatibility between different binder types and additives. This includes compatibility between binder sources (different virgin sources, or between virgin and recycled) as well as between binders and recycling agents (RA) that are added to mixtures with high recycled asphalt material (RAM) contents. The consequence of incompatibility may be inferior pavement performance and longevity, requiring more frequent maintenance and rehabilitation. Agencies need a practical and implementable characterization system to determine the compatibility between binder types and additives. Rheological parameters such as ΔTc and phase angle are often used as compatibility indicators; however, limited validation exists between such parameters and direct analytical measures of binder compatibility.

A comprehensive state of the art review on the available tools and techniques to more directly assess the compatibility of complex binder blends was conducted in both the field of asphalt materials and organic chemistry/polymer science. Promising tools and methods that were identified from the review were grouped into four categories based on their evaluation purpose and testing procedures: 1) analytical methods; 2) microscopy technique; 3) thermal property characterization. and 4) binder performance tests. The binder colloidal indices (e.g. Asphaltene Index (IA) and Gaestel Index) and functional group indices (e.g. carbonyl and sulfoxide peak/area), and the thermal events/parameters (e.g. glassy transition region/temperature (Tg) and wax crystallization/ precipitation (C(t))) measured from binder analytical and thermal characterization methods have been shown to be able to identify the compatible and incompatible binder blends. Morphological mapping using microscopy techniques can be directly used to detect the issue of phase separation. The potential for correlating such measures with more conventional rheological parameters (e.g. ΔTc and Glover-Rowe parameter), and binder performance parameters measured from non-linear range test methods (e.g. Linear Amplitude Sweep (LAS), Multiple Stress Creep Recovery (MSCR) and Double-edge-notched Tension (DENT) Test) are also considered.

A laboratory testing campaign consisting of two different RA, three RAM sources and three base binders, which serve as the reference material with the historical testing/performance data available, is currently undertaking. Considering the results observed from the review, the representative and promising testing methods and corresponding output parameters are selected and being performed on the study material base. In addition, several mixture performance testing are also included and being conducted to evaluate the combability in the mixture state. The results generated from the various binder and mixture evaluations will be used to determine the priority of the tests and screen out the methods and tools that are most sensitive and able to differentiate the compatibility of asphalt material caused by change of blend/mix components, and will be further validated and proposed as the characterization system to assess the compatibility of asphalt material considering both effectiveness and efficiency.

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Paper : **3**

The Use of Infrared Joint Heaters to Improve HMA Construction Joint Density and Overall Performance

Vince Aurilio, Bob Kieswetter

Premature failure of asphalt longitudinal construction joints continues to be an issue and a concern of roadway authorities around the world. The key factor affecting joint performance is generally insufficient compaction or low density (high air voids). Poor joint construction or workmanship often contributes to the performance problems. This results in the joints opening and raveling and commonly the occurrence of multiple cracks along the joint. If left unattended (i.e., with little or no maintenance) the joint issues will greatly impact the overall performance of the pavement. The problem is typically related to the cold joints and/or lack of compaction of the unconfined edge of pavement. It has generally been accepted that the requirements for joint compaction are typically 1.5-2.0 % lower than the main lane requirement. However, this requirement is often not met, and the in-place air voids are much higher than desired or expected. Hence, it has become apparent that these specification requirements need to be revisited by the various stakeholders and improvements or 'raising the bar' with respect to joint density is essential. Different methods (i.e., construction techniques and equipment) have been employed to correct this problem and ideally the solution is to avoid constructing cold joints wherever possible, which is not always the case. For example, using paving in echelon, where practically viable, to maintain a hot joint between passes is known to provide the best overall performance. Other approaches have been utilized with varying degrees of success and it is often recognized that there may be more than one way to properly construct and compact longitudinal joints. Infrared joint heaters that pre-heat the joint prior to paving the second lane have been successfully used for over twenty years and are becoming more common as a very effective method to improve joint density and performance. For instance, the City of Hamilton has specified the use of infrared joint heaters since 2007 where maintaining a hot joint is not viable. Various independent studies have shown that using joint heaters provides better compaction (lower in-place air voids) and lower permeability and ultimately improves the bond between passes resulting in longer durability. This paper will provide an in-depth review of the construction issues associated with longitudinal joint construction. This review will include current use of infrared joint heaters, and the associated specifications along with observed performance improvements. New developments or advancements in equipment to control joint density (e.g., GPR equipment) will also be presented. For example, in Alaska GPR is being reviewed in conjunction with joint heaters to verify joint density.

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Paper : **4**

Development of High Stability and Fuel Resistant Airfield Asphalt Mixture

Sina Varamini, Mohammed Ahmed, Kevin Chee, Zlatko Brcic, Michael Esenwa

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 aircrafts, combined with extreme climatic conditions. Additionally, asphalt surfaces could be exposed to fuel spills and/or de-icing chemicals which can further lead to accelerated deterioration of asphalt mixes. So, it is extremely important for airport owners to utilize asphalt mixtures that provides increased level of resistant to load-associated and environmental surface distresses, while providing high level of resistant to detrimental effects of fuel and hydraulic fluid spills.

This paper provides information on steps employed in designing a high stability and fuel-resistant asphalt mixture for the busiest airport in Canada, the Toronto Pearson International Airport. The design was completed by considering the Federal Aviation Administration (FAA) AC150/5370-10H Item P-404, commonly referred to as “Fuel-Resistant Asphalt Mix Pavement”.

The design process involved: (1) development of an asphalt binder containing specialty modifiers and additives to resist the softening effect of light hydrocarbon fractions, such as fuels and lubricants, (2) designing an aggregate blend to provide high level of stability, and (3) performance testing to capture the mechanical properties of the mixture compared to a conventional asphalt mixture used at the Pearson airport.

Performance testing included: (a) 24-hour fuel immersion test, (b) rutting performance by using Asphalt Pavement Analyzer, Hamburg Wheel Tracking Test, and Flow, (c) compression-tension fatigue and dynamic modulus, and (d) Tensile Strength test.

Production and paving experience observed during the first-in-Canada field trial are also included in this paper. This paper further explains the applicability of methodology adopted to develop this mix to other airports in Canada.

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Paper : **5**

Comprehensive Evaluation of Disc-Shaped Compact Tension and Semi-Circular Bend Tests as Asphalt Mixture Durability Indices and Performance Acceptance: Ontario Experience

Saeid Salehi-Ashani, Sina Varamini and Susan Tighe

Asphalt mix is a viscoelastic material, where its characteristics strongly depend on temperature, loading rate and aging level. Cracking is considered as a dominant failure mode in flexible pavements that occur mainly in the form of longitudinal fatigue, transverse thermal, and reflective cracking. Among which, fatigue and thermal cracking occur at intermediate and low temperatures that are the most prevalent type.

In General, fatigue cracking occurs in consequence of repetitive traffic loading inducing tensile strain at the bottom of asphalt layer. Although fatigue characterization techniques using cyclic loading either in flexural or uniaxial mode have been long established, development of simple, timely, and affordable techniques that can capture the fracture properties of asphalt mixtures is considered very beneficial in evaluating durability.

Unlike fatigue cracking, thermal cracking or the low-temperature cracking is cited to be almost controlled by adverse environmental conditions and the low temperature properties of the asphalt binder. The ability of asphalt binder to relax to a reasonable confidence level is captured after conducting Bending Beam Rheometer (BBR) test. However, to evaluate the resistance of asphalt mixtures to thermal cracking, not only is the characteristics of asphalt binder as a component of asphalt mixtures significant, but also the aggregate gradation, the physical and chemical interaction between binder and aggregate, binder adhesion and cohesion of asphalt mix must be considered.

Considering the recent advancements in the laboratory characterization of asphalt mixtures, fracture-mechanics-based tests have shown promising. For instance, Semi-Circular Bend Test, or the Illinois Flexibility Index Test (I-FIT) as per AASHTO TP124, has been utilized as a quick and simple test to evaluate crack resistance of asphalt mixtures at intermediate temperature in number of agencies as contractual performance index. Moreover, Disc-Shaped Compact Tension (DC(T)) test as per ASTM D7313 standard has shown promising ability in capturing thermal crack resistance of asphalt mixtures. Overall, such tests could be potentially utilized toward implementation of a Balanced Mix Design (BMD), or also referred to as “Engineered Mix Design, EMD”, process as well as a quality assurance tool, assisting with crack resistance evaluation of asphalt mixtures at the production level.

In this study, the effect of testing variability regarding aging and temperature on I-FIT and DC(T) results were investigated. For this purpose, five plant produced surface course asphalt mixtures that were used in several paving projects across Ontario were collected. The mixtures cover asphalt binder grades of PG52-40, PG58-34, PG64-34, PG64-28, and PG70-28. First, the effect of two different laboratory oven aging, including 120 hours at 85ºC and 72 hours at 95ºC on the results of I-FIT and DCT test was investigated. Secondly, I-FIT was conducted at three temperatures, including 23ºC, 24ºC and 25ºC, to investigate the effect of temperature sensitivity. Thirdly, DC(T) test was conducted at three temperatures, namely -18°C, -24°C and -30°C to capture the effect of temperature on the results.

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Paper : **6**

Rheological and self-healing properties of modified asphalt binders using nano clay

Leila Hashemian, Liniker Monteiro; Mohammad Shafiee

Increasing traffic loads and climate stressors are driving the deterioration of asphalt concrete pavement. In response to these challenges, asphalt binder modification has surged with emerging technologies to improve both mechanical and rheological properties of the material. Notable among novel approaches in asphalt binder modification, nanomaterials have great capability to alter the asphalt binder behaviour due to their size. In this study, nano clays were investigated for binder modification on the laboratory scale. Nanoclay-asphalt modification has a high potential to increases the self-healing behaviour of the binder. Healing is an intrinsic ability of asphalt, meaning it has the ability to repair itself, recovering mechanical properties after micro-cracking. The asphalt binder is responsible for all the mixture's recovery of properties after cracking, so by improving the asphalt's healing behaviour, it is expected that healing will also be improved in the mixture. Although this phenomenon has been discovered in the 1960s, the underlying factors are not well known. Temperature, aging, and cohesion properties have been shown to influence this action greatly. This study focused on determining the intrinsic healing potential of nanoclay modified asphalt via utilizing two different types of organo-modified montmorillonites (OMMT) including Cloisite® 15A and Cloisite® 20A, at 2% and 4% dosages. The effectiveness of the high shear mixing method was analyzed using a Scanning Electron Microscope (SEM). The Superpave performance grading (PG) of all the binders was analyzed before and after modification. The two-piece healing (2PH) test using a Dynamic Shear Rheometer (DSR) was conducted to measure the healing behaviour of these binders compared to the unmodified binder. All modified binders were also aged using a rolling thin film oven (RTFO) and pressure aging vessel (PAV), to investigate their healing potentials after aging.

Paper : **7**

Impacts of Mixer Types and Mixing Time for Hot-Mix Asphalt (HMA) with High Reclaimed Asphalt Pavement (RAP) Content on Mixes Performances.

Marc-André Bérubé, Samuel Laliberté, Jimmy Hawey, Kevin Bilodeau and Alan Carter

It is difficult to make in laboratory asphalt mixes that closely represent mixes made in the field because the equipment used is different and because of the scale of the production. The mixing process in laboratory is done following specific standards, but for some aspects, those standards only give recommendations and present some limits. The laboratory methodology used to produce asphalt mixes may affects the properties and performance of the mixes. For the mixing part, the mixing energy, equipment and duration can have significant effects on the asphalt mixes properties even when done in agreement with the standards. The goal of the study presented in this paper is to evaluate the impact of the mixing process in laboratory for Hot-mix Asphalt (HMA) with high RAP content on its volumetric and thermomechanical properties.
In this study, a single HMA with 30% RAP was prepared in laboratory with three types of mixers. The first one is a standard lab mixer, a Hobart Model HL-200, the most common in the industry. The second one is a large Infratest thermoregulated laboratory model 30 mixer, a new kind of mixer that provides a better temperature control and a bigger material capacity. The last mixer is a Wirtgen model WLM 30 Twin-Shaft PugMill mixer which is normally use for cold asphalt mixes. For all the mixes, the mixing temperature, the compaction temperature and the virgin asphalt cement type remain the same. For each mixer type, four mixing times were selected based on the mixer properties. All the mixes were firstly tested for their compactability with a Superpave Gyratory Compactor (SCG). Bitumen of the mixes sampled from the SCG specimens were then test on Fourier-transform infrared spectroscopy (FTIR) apparatus to evaluate the impact of mixing on bitumen oxidation. Finaly, the linear viscoelastic characterization of bituminous mixture were evaluated with dynamic tests (waves propagation) and traction-compression complex modulus tests. Voids during the SCG compaction have changed with the mixing time for all mixer types and is different according to the mixer used. As expected, FTIR shows that the oxidation of the bitumen is more obvious at longer mixing time. As for stiffness, results changed through the mixing time and an optimum was obtained for each mixer type.

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Paper : **8**

Comparison of Asphalt Emulsion Stabilized Base Courses Modified using Cement or Asphaltenes

Leila Hashemian, Muhammad Misbah Uddin, Farshad Kamran, Benjamin Corenblum

The base layer is an essential part of the pavement structure to distribute the traffic load towards the subgrade. Deformation, fatigue cracking, and moisture damage are typical distress in the pavement due to excessive traffic load and environmental effects. Stabilization is one of the best methods to improve the base layer performance could be used to achieve sufficient bearing capacity and resist these problems. Soil stabilization using asphalt emulsion is a well-known strategy used to increase the strength of base course layers. However, the main challenges of using this technology in cold regions include the sensitivity of the stabilized layers to permanent deformation and moisture damage. The addition of some cementitious materials such as cement, hydrated lime or fly ash may increase the bonding between bitumen and aggregates, thus resulting in a stiffer and more durable mix. However, the use of these materials increases the rigidity of the stabilized mix and thus increases the potential for cracking. Asphaltenes extracted through deasphalting of oil sands bitumen are a waste material with no significant use in the road industry. In the previous research, it was shown asphaltenes could be used as an appropriate modifier to enhance the mechanical properties of asphalt-emulsion stabilized mixes, including compressive strength, permanent deformation and tensile strength without causing a significant stiffness and cracking problem. This study aims to compare the impact of the addition of cement or asphaltenes on the mechanical properties of asphalt emulsion stabilized mixes.

In this study, after preparing a mix design for a stabilized base course using asphalt emulsion, different amounts of cement or asphaltenes (1% and 2% per weight of total mixture) were added to the mixture. Performance properties of the mixes, including Indirect Tensile Strength (ITS), creep compliance and shear strength, and permanent deformation, were determined and compared. In addition, IDEAL-CT test was used to evaluate the cracking resistance in mixes. It was found that the addition of asphaltenes had a greater impact on increasing the mixes strength and cracking resistance of the mixes compared to cement. However, asphaltenes-modified samples were found to be more susceptible to moisture damage. IDT test results revealed that cement-modified samples were more prone to low temperature cracking compared with the asphaltenes-modified mixtures.

Paper : **9**

Development and Field Experience with Performance-Based Asphalt Mixture Used in Thin Asphalt Pavements

Sina Varamini, Michael Esenwa, Matt Kennedy

This paper presents an asphalt mixture solution that can be place as a thin-layer (less than 40 mm) over granular base to provide a hard-top driving surface. This paper further provides steps in understanding the response of Thin Asphalt Pavements (TAP) and steps required to translate such responses into developing a performance-based requirement for the asphalt mix. The performance-based design steps are explained in this paper to provide an insight into how low-temperature flexibility and long-term fatigue behavior of a mix is assessed and related to repetitive stresses expected from low to medium level of traffic coupled with environmental conditions expected in Southern Ontario. Production and paving experience with this asphalt mix solution are also included in this paper, as well as more than two-year field performance of a trial section in Southern Ontario.

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Paper : **10**

Evaluating Low-Temperature Cracking Resistance of Recycled Asphalt Mixtures Using a Modified IDEAL Procedure

Hussain Bahia, Yuan Zhang

An increasing interest in using high contents of Reclaimed Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS) in the production of Hot Mix Asphalt (HMA) is emerging in cold regions. With this increased interest, recycling agents used to offset the stiffening effects of aged recycled asphalt binders are being provided in the market. One of major concerns with high recycled asphalt materials incorporated with recycling agents is the thermal cracking resistance of those mixtures. Extensive research has been conducted on evaluating low temperature thermal cracking of HMA mixtures through several standard methods, such as the Disc-Shaped Compact Tension (DCT), Semicircular Bend Geometry (SCB), and Indirect Tensile Test (IDT). However, one of the main challenges in using these tests is the observation of extensive aggregate fracturing during the standard thermal cracking tests. It is believed that such aggregate fracturing is not representation of field conditions and can interfere with measuring the effects of recycled binders and recycling agents on asphalt mixtures.

Therefore, in this study testing results of SCB, DCT and IDEAL for recycled asphalt mixtures were reviewed to understand limitation of those standard methods in characterizing the low-temperature cracking resistance. A modified procedure of Indirect Tensile Cracking Test following the (IDEAL) procedure was developed to reduce or eliminate aggregate fracturing during the cracking tests through adjusting testing temperatures and strain rates. The modified IDEAL test was used for testing high recycled asphalt mixtures to evaluate effects of RAP amount, recycling agent, and extended laboratory aging on low-temperature cracking resistance. Four types of mixtures with distinct contents of recycled asphalt materials were prepared in the laboratory: virgin mixture, 30%RAP mixtures, 50%RAP mixtures, and 30%RAP + 5%RAS mixtures. For those recycled asphalt mixtures, one Re-refined Engine Oil Bottoms (REOB) and two Bio-Oils were added at pre-determined dosages for restoring the mixture performance. Both the virgin mixture and recycled asphalt mixtures were subjected to two levels of laboratory aging: short-term oven aging (STOA) for 4 hours, and long-term oven aging (LTOA) for 8 hours using loose mixtures at 135 oC. The cracking parameters, CTindex and Post-Peak Slope, were determined for the high recycled asphalt mixtures and compared with the virgin mixtures at two aging levels.

In addition, blended binders corresponding to each mixture were prepared through mixing virgin binder with the extracted and recovered RAP/RAS binders and recycling agents following the proportions used in the mixtures. The blends were subjected to the Rolling Thin-Film Oven (RTFO) and Pressure Aging Vessel (PAV) aging conditioning prior to the Bending Beam Rheometer (BBR) tests. The results of mixture CTindex measured with the modified IDEAL procedure correlate very well with the blended binder's BBR results, indicating that the modified IDEAL test procedure is successful in reducing the interefernce of aggregates' fracturing and showing effects of binders' low-temperature properties on the recycled asphalt mixtures.

Keywords: Recycled Asphalt Mixture, Low-Temperature Cracking Resistance, Indirect Tensile Asphalt Cracking Test, Aggregate Fracture, Bending Beam Rheometer, m-value

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Paper : **11**

Surface renewal of an urban motorway in the Montreal area using an ultra-thin asphalt concrete pavement (béton bitumineux ultra-mince)

Jean-Martin Croteau, Patrice Richard, Denis Veillette, Kevin Bolduc

In the summer 2020, Sintra Inc. performed paving work on behalf of Entretien Miller Ltée. to renew the surface characteristics of 35 lane-km of the A25 Concession urban motorway main alignment in the Montreal area. The selected paving solution needed to satisfy, an operational requirement, rapidity of execution as the work needed to be performed at night in short shifts, and a functional requirement as the technique needed to provide performance sustainability in terms of smoothness, rolling noise, adherence, rutting and surface defects.

Incidentally, the challenges related to surface renewal paving work of A25 Concession quickly lead to the selection of an ultra-thin asphalt concrete pavement (béton bitumineux ultra-mince) as the preferable paving solution to satisfy both the operational constraints for the work and the functional requirement for the long term performance of the roadway.

There is a long history of successful applications of ultra-thin asphalt concrete pavement in France and in the USA with the ultra-thin bonded wearing course technique. The uniqueness of the application of this product for the A25 Concession relates to the paving technique, which allowed the usage of conventional equipment and the specificities of the tack-coat to avoid both, the bleeding in the wheel path caused by the kneading of the traffic and the plow damage outside the wheel path caused by aggressive snow removal in the winter.

The uniqueness of the work brought also a series of challenges to ensure that the work performed would satisfy the set objectives. This paper provides information on the pavement engineering that lead to the selection of the ultra-thin asphalt concrete pavement. It provides the reasons as to why it was critical to select a paving technique with an aggressive surface texture to satisfy the contract adherence requirements. Information is provided as to how the specifications were developed to facilitate both: the development of a detailed Quality Plan and for the administration of the work. Finally, results as to the performance of the work in terms of adherence, smoothness and rolling noise are presented.

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Paper : **12**

Use of OGFC to Address Drainage Issues for George Massey Tunnel

Vipin Sharma, Art Johnston

The George Massey Tunnel is a major Fraser River Crossing on Highway 99 in Lower Mainland Vancouver connecting the Cities of Richmond and Delta. It is a 4-lane tunnel with an average daily traffic of about 100,000 vpd. It is congested and experiences long delays especially during the peak hours. The tunnel was constructed in 1950's and is close to the end of its service life. The Province of British Columbia is considering the options to replace the existing tunnel with a new tunnel or a bridge, which will be constructed in the near future.

The approaches to and from the tunnel in both directions have been exhibiting water seepage issues for the past several years. The river water seeps through the joints of the approach slabs and pavement surface stays wet for most of the times even during dry weather. Water seepage poses safety concerns during the winter season. Continuous water seepage results in poor pavement performance as well and the Ministry has been maintaining the pavement by regular (every 2 – 3 years) mill and inlay of the pavements at approaches to the Tunnel.

Considering that the existing tunnel will be decommissioned soon after the construction of the new crossing, Ministry was looking at a solution to fix the water seepage issues in the short term (5 – 10 years life expectancy). Different options such as use of Permeable Portland Cement Concrete Pavement, Open Graded Friction Course (OGFC) Asphalt Pavement surface, grouting / sealing of the joints in the approach slabs etc. were considered.

As there was a concern for the clogging of the voids in the OGFC layer, a solution involving the placement of Open Graded Asphalt Pavement as a drainage layer on top of the approach slab was constructed. Two lifts of conventional HMA was placed on top of the drainage layer. This allowed for the seeping water to flow through the drainage layer without reaching the pavement surface.

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Paper : **13**

Uses and Applications of High Modulus Asphalt for Cold Climate

Marc Proteau, Amélie Griggio, Sébastien Lamothe, Alan Carter, Daniel Perraton

ABSTRACT

High modulus asphalt concretes (HMAC) using very hard bitumens were developed in Europe in the 1980s. This type of mix with adaptations for the northern climate was introduced in Canada in 2012. These high-performance mixes have distinct rheological characteristics superior to conventional hot mix asphalt (HMA), particularly in terms of structural contribution with an exceptional “modulus of rigidity-fatigue strength” couple. Their adaptations to the Canadian climate must also be ensured by sufficient resistance to low temperatures. Their formulations are ensured by advanced laboratory analyzes and based mainly on measurements of mechanical performances such as their modulus of rigidity, their resistance to fatigue, thermal cracking, rutting and their water sensitivity.

Their uses allow the construction of flexible pavements highly stressed both in urban as for motorway traffic and also for industrial areas. The determination of their thicknesses is ensured by mechanistic calculations allowing the enhancement of the superior performance of these mixes, with the use of the Alizé software or the OPECC calculation tool. The structural calculation analyzes are based on the modeling of road traffic or special rolling loads in the field of industrial pavements, and of the pavement structure in multilayer models, ensuring the optimization of their dimensions in terms of the admissible cumulative damages.

This article focuses on the formulation approach, the structural contribution in comparison to conventional mixes and presents several examples of applications both in new constructions and in reinforcement, for various environments.

RÉSUMÉ

Les enrobés à modules élevés (EME) à base de bitumes très durs ont été développés en Europe dans les années 1980. Ce type d’enrobé avec adaptations pour le climat nordique a été introduit au Canada en 2012. Ces enrobés à hautes performances présentent des caractéristiques rhéologiques nettement supérieurs aux enrobés bitumineux (EB) classiques, notamment en termes d’apport structural avec un couple « module de rigidité-résistance en fatigue » exceptionnel. Leurs adaptations au climat canadien doivent également être assurées par des résistances suffisantes aux basses températures. Leurs formulations sont assurées par des analyses en laboratoire avancées et basées principalement sur des mesures de performances mécanistiques tels que leurs modules de rigidité, leurs résistances à la fatigue, à la fissuration thermique, et à l’orniérage, ainsi que leurs tenues à l’eau.

Leurs usages permettent la réalisation de chaussées flexibles fortement sollicitées aussi bien en milieu urbain que pour le trafic autoroutier et également pour les aires industrielles. La détermination de leurs épaisseurs est assurée par des calculs mécanistiques permettant la mise en valeur des performances supérieures de ces enrobés, avec l’utilisation du logiciel Alizé ou l’outil de calcul OPECC. Notamment, les analyses de calculs structuraux sont basées sur la modélisation des charges roulantes routières ou spéciales dans le domaine des chaussées industrielles, et de la structure de chaussée en modèles multicouches, assurant l’optimisation du leurs dimensionnements en terme du dommage cumulatif admissible.

Le présent article porte sur l’approche de formulation et l’apport structural des EME en comparaison aux EB usuels et présentent plusieurs exemples d’applications autant en constructions neuves qu’en renforcements et ce, pour divers milieux.

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Paper : **14**

High-float Emulsion Residue: Suitable Methods and Metrics for Testing Viscoplastic Materials

Justin Suda, Sina Varamini. Elijah Bickle

Despite the advantages of high-float (HF) emulsions, formulations are difficult to optimize. Current high-float (HF) residue testing practices rely on empirical measurements to describe the "consistency or flow behavior" of the material and lack any kind of rigorous intensive characterization. By revealing the underlying science of HF systems, tests informally known as the penetration test (ASTM D5 and AASHTO T49), the viscosity test (ASTM D2171 or D4957 and AASHTO T202), and the float test (ASTM D139 and AASHTO T50) will become obsolete for this class of non-Newtonian material.

While there are many classes of non-Newtonian behavior, HF residues can be best described as time-independent fluids or more precisely viscoplastic fluids. From previous Canadian Technical Asphalt Association (CTAA) proceedings, we know that HF residues—especially those associated with chip-seal and cold-mix applications— exhibit a yield stress, which can be easily quantified using a stress-ramp procedure on a dynamic shear rheometer.

This technical paper is a sequel to the CTAA paper titled, High-float Emulsion Residue: Its Unique Rheology and Microstructure, where we will report a detailed review of current HF residue testing, and provide insight on how these tests may be able to be replaced by one-single, more practical test procedure. In addition to rheological studies, employment of various residue recovery techniques where used to help explore the effect of distilling an HF emulsion. Based on the findings, the stress-ramp procedure can be used to set appropriate shear rates for specific HF residues, measure apparent viscosity, and indicate whether the residue is effectively viscoplastic.

Paper : **15**

Investigation of Field and Laboratory Test Methods in Evaluating Rutting and Shoving at Intersections; Municipal Perspective

Mehran Kafi Farashah, Dr. Sina Varamini; Dr. Susan Tighe; Dr. Hassan Baaj

Due to continuous increase in the number of truck traffic loading to accommodate the population growth's needs, and also due to the impact of climate change, York Region is experiencing premature pavement failure in many of its heavy truck traffic intersections mostly in the form of pavement deformation or rutting and in some cases shoving. It is evident that the conventional pavement materials that have been used for the high truck traffic intersections in the Region are not sufficient for meeting the expected design service life. As a result, six (6) approach intersections were selected at the Region to investigate the in-service performance and root cause of the rutting and shoving. The sites were selected to present the three most used conventional surface layer asphalt mixes in the region in the past decay or so. The study consisted of conducting field measurement of rutting depth and geotechnical investigation such as extracting core specimens, boreholes, and transverse Ground Penetration Radar (GPR) survey. The study further developed a ranking system to better characterize all surface mixes utilized at the six intersection. The ranking system considered significant factors related to rutting and shoving at intersections, including; truck percentage, asphalt layer thickness, average asphalt surface rut depth, asphalt layer age, and the number of lanes.
An array of laboratory testing was developed to test the level of resistance to rutting and shoving at the intersections. The testing program included; (1) Hamburg Wheel Tracking Device (HWTD) to evaluate the rutting resistance of mixtures as well as moisture susceptibility of compacted specimens while submerged in water, (2) the repeated load permanent deformation test or Flow Number (FN) test for predicting the rutting responses of asphalt mix, (3) newly developed Uniaxial Shear Tester (UST) and (4) IDEAL rutting test (IDEAL-RT) to measure the shear properties of asphalt mixes. In addition, Dynamic Modulus test was conducted to determine material property which could be used for Level 1 Mechanistic-Empirical Pavement Design Guide (MEPDG) to determine rutting and cracking distress development and propagation.

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Paper : **16**

High-Strain Asphalt Interlayer for Reflective Cracking: A 20+ year review

Phillip Blankenship, Zach McKay

Since the early 1990's, asphalt interlayers of about 25 mm thick have been used in the US to slow the onset of reflective cracking over Portland cement concrete and asphalt pavements. Koch Materials Company introduced asphalt interlayer technology to the US which had been previously used in France. The asphalt interlayer mixture is a 4.75mm top-size mixture comprised of fine aggregate with high dust (8.0%+ passing 75-micron sieve) and high asphalt content (8.0%+ AC). This is not just a "recipe" mixture, but a performance-based specification that consists of a high-strain (2,000 microstrain), 4-point flexural beam fatigue test (ASTM D8237)) to ensure extreme flexibility and a mixture stability test for adequate rut resistance (1, 2). Interlayer test sections were placed strategically thought the US in various climatic zones to further adjust the performance specification and testing temperatures.

By 2006, the interlayer was more mainline and further investigated under a National Science Foundation's (NSF) Grant Opportunities for Academic Liaison with Industry (GOALI) joint proposal between University of Illinois and Koch Materials Company (3,4). The Disk-Shaped Compact Tension (DCT) test (ASTM D7313) was developed under this body of work and utilized to further understand the extremely high-strain properties of the interlayer of which new finite element models were created (5,6). As of 2006, it was reported through Koch and SemMaterials from project data (unpublished) that an average of 71% improvement was experienced in reflective cracking on high-polymer, performance designed interlayer projects as compared to control sections. This data represented up to 18 projects up to four years old.
Today, the asphalt reflective crack relief interlayer (RCRI) is called by several names and used in some form in Texas, Kentucky, Kansas, Wisconsin, Iowa, and New Jersey. More recently, a general aviation airport pavement in Kentucky was showing signs of early pavement distress and micro-cracking in spring 2018. The consultant required the use of an asphalt RCRI. Because of the location of the project, high-polymer asphalt binder was not available on quick-demand, so aramid fiber was used to meet performance-based specifications. At last visit in fall 2020, the pavement was performing well with no signs of distress.

With the need to control cracking and availability to use other materials such as aramid fiber, RCRI is a valid option for contractors to use local materials to build asphalt interlayers to control/retard cracking. Today, the interlayer can be designed with newer tests like IDEAL-CT (ASTM D8225) or flexural beam fatigue coupled with a rutting test such as the Hamburg Wheel Tracker (AASHTO T324), all with climate-adjusted test temperatures.

2021 Paper Abstracts in Tentative Presentation Order

Paper : **17**

Using Bio-Modifiers for Recycling RAP and Improving the Performance of RAP-Incorporated Mixtures Designed for Different Pavement Demonstration Projects

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This research summarizes the results obtained from rheological and mechanical performance tests performed on bio-modified asphalt binders and mixtures. These asphalt materials contained reclaimed asphalt pavement (RAP) at varying contents, and were prepared for pavement demonstration projects that occurred in four different locations in the U.S. states of Minnesota, Iowa, and Indiana. The latitudes of these locations range from 36.9 to 46.7°, and the content of RAP used in the projects varied from 20 to 40%. To mitigate the detrimental effects of RAP at low temperatures and improve the high temperature performance, the asphalt binders and/or mixtures were modified with three types of soybean oil derived modifiers: sub-epoxidized soybean oil (SESO), epoxidized methyl soyate (EMS), and poly(acrylated epoxidized high oleic soybean oil) (PAEHOSO). These bio-modifiers were engineered and advanced over a decade as part of a program for increasing the sustainability of U.S. asphalt pavements made with RAP-incorporated mixtures. The EMS and SESO are bio-renewable reactive restorative modifiers (RRMs) that were used for recycling the RAP and increasing the mixtures' resistance to low-temperature cracking. The PAEHOSO is a bio-renewable polymer modifier that was used for increasing the mixtures' resistance to rutting. Performance grade (PG) and multiple stress creep recovery (MSCR) tests conducted on the asphalt binders proved that the EMS and SESO can successfully restore the low-temperature grades of asphalt binder blends – e.g., those made of RAP and virgin binders - to levels identical to non-modified binders containing no RAP binder. These tests also revealed that the PAEHOSO has a huge influence on improving the high temperature properties and increasing the elastic recovery of binder blends due to the formation of large polymer networks. Disk-shaped compact tension (DCT) and Hamburg wheel tracking (HWT) were the mechanical performance tests used for evaluating the mixtures' resistance to low-temperature cracking and rutting, respectively. According to the results obtained from the DCT test, the SESO and EMS, when used for modifying the asphalt binders and mixtures at appropriate dosages - that were selected based on the RAP content and the low temperature grade of asphalt binders -, can successfully increase the low temperature cracking resistance. Based on the HWT test results, the PAEHOSO has a significant influence on increasing the resistance to rutting and low temperature cracking that is all due to increasing the elasticity of asphalt mixtures.

Paper : **18**

Effect of Biochar in Asphalt Mixes

Ola Oluwasewa Owolabi, Ola Oluwasewa Owolabi, Xiomara Sanchez-Castillo

Every year, the government spends a huge sum of money on repairing the roads. The damage incurred on the roadways is attributed to several factors such as climate, traffic, bad construction practices, etc. Another factor is the asphalt mixes used to pave the roadways, as sometimes, raw asphalt binder does not have adequate properties to make the roadways durable. Therefore, the improvement of asphalt mixes sometimes entails the incorporation of additives or modifiers to enhance the performance of asphalt pavements.

Various types of additives are being used and discovered from time to time, an example of this additive that draws the attention of this research is biochar. Biochar is a carbon-rich by-product of the thermal conversion of organic feedstocks such as wood, manure, or leaves through a process known as pyrolysis. Biochar is considered a waste product, and since it is high in carbon content, putting it to waste can result in environmental pollution, which in turn drives global warming. Therefore, it is important to put the biochar to good use instead of letting it go to waste.

This study aims to examine the effect of incorporating biochar in the asphalt mix. The motivation behind this study is that several studies have been conducted on the effect of biochar on the asphalt binder; however, not much has been done to study the effect of biochar on the asphalt mix, so this study will help bridge the gap of a lack of substantial research on the asphalt mix.

2021 Paper Abstracts in Tentative Presentation Order

Paper : **19**

A Country-wide Survey to Understand Pavement Management Practices in Canada

Shajib Guha, Kamal Hossain

Canada has over 1.13 million kilometers of roads (two-lane equivalent km), making her the seventh-largest road network bearer in the world. Roads in Canada are managed primarily by four different jurisdictions such as federal authorities, provincial authorities, territorial authorities, and regional authorities. Federal authorities manage the federal highways and roads in the national parks, provincial and territorial authorities are responsible for managing provincial and territorial roads, respectively. Trans Canada highways are also managed exclusively by the provincial and territorial authorities, while regional authorities are responsible for managing local roads and streets. Approximately 80% of public roads in Canada are governed by the regional authorities, which refer to cities, towns, and municipalities, making them the most important contributors to the Canadian road management system. To understand the management practices at the regional level, a country-wide road management survey was conducted. The survey covered all the essential components of a management system, such as road type inventory information, road condition assessment system, treatment programs, maintenance priority program, and pavement performance prediction models. 39 cities, towns, and municipalities from nine different provinces participated in this survey and yielded a great amount of data to explain contemporary roadway management practices in Canada at the regional level. The survey results not only describe different pavement management practices in different provinces but also finds the gap in those practices and provides recommendations for further improvement of the existing practices.

Paper : **20**

Selection of Appropriate Binder Grade for Changing Climate and Its Influence on Pavement Performance

Surya Swarna, Kamal Hossain, Alyssa Bernier

In the coming years, it is anticipated that the current Canadian climate will no longer be the norm, and temperatures will be increasingly different as a result of anthropogenic climate change. Increased greenhouse gas concentrations in the atmosphere are at the root of changing climate, which is only expected to worsen over time. Pavement performance models show that changing climate will result in accelerated pavement deterioration. To mitigate pavement deterioration, various adaptation strategies have been suggested in the recent literature. One of these adaptation strategies is upgrading the superpave asphalt binder grade. It is well known that asphalt binder is highly sensitive to climate factors such as temperature and percent sunshine. Hence, reviewing asphalt binder grade is a vital step, and that can help decelerate pavement deterioration. This study aims to understand the impact of climate change on existing flexible pavements and identify the appropriate binder grades necessary to accommodate these effects across Canada. To achieve this goal, the analysis was carried out in six phases. In the first phase, statistically downscaled climate change models were gathered from the Pacific Climate database. Then in the second phase, hourly temperature and precipitation data were estimated using existing hourly data and state of the art estimation models for each day throughout the design period. Later in the third phase, the pavement materials, traffic, and structural data are collected from reliable sources such as provincial departments of transportation (DoTs) and the Long-term pavement performance (LTPP) database. Then in the fourth phase, the pavement performance was assessed using AASHTOware Mechanistic-Empirical (ME) Pavement Design. In the fifth phase, using the temperature data gathered from pacific climate, asphalt binder grades were determined for the future climate. Then in the final phase, the pavement performance is again determined with the proposed future asphalt binder grades. Comparing the pavement performance between base binder grade and the proposed future binder grade confirms the necessity of considering proposed asphalt binder grades for future climate.