Asphalt Innovation Symposium 2021

Research meets industry

Dec 15-16, 2021 in Antwerp

Book of abstracts

Editors:

W. Van den bergh

N. Hasheminejad

Universiteit Antwerpen

Contacts
Prof. Wim Van den bergh (Wim.Vandenbergh@UAntwerpen.be)
Dr. Navid Hasheminejad (Navid.Hasheminejad@UAntwerpen.be)
University of Antwerp
Faculty of Applied Engineering

EMIB Research Group
Groenenborgerlaan 171, 2020 Antwerp, Belgium
W: https://www.uantwerpen.be/en/research-groups/emib/rers/about-us/
T: +32 326 51 932

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Preface

Dear attendee and reader,

Welcome. Before you, the book of abstracts of the asphalt innovation symposium 2021 is presented. We are proud of it. For the fourth time already, we are bringing research and industry together.

Innovation in road construction is crucial, with different actors to support it. Often, we end up in a cycle in which the client and the contractor point to each other for the initiation of this innovation, and especially its application. This symposium takes this responsibility upon itself to discuss the various creative ideas and questions, to give them a platform, to give you a platform to present new ideas.

Innovation once started from economic reasons, take for example recycling. What is the added value of recycling, how can we make mixtures with recycling durable? The research at the University of Antwerp started with this topic, by the way. Using waterproofing waste in asphalt mixtures, in 1997. Meanwhile, we go much further and calculate the impact of innovations on ecological and social levels. The research questions concerning recycling have been joined by other research topics, such as the use of intelligent sensors and data analysis, bio-binders, chemical components affected by ageing, rejuvenators, green public procurement, new materials, air purification techniques, and heat-island solutions.

With this symposium, we especially want to support the asphalt sector to further innovate in a sustainable way. Innovation ensures higher social development, with more conscious choices and more efficient methods. The word 'sustainability' will be used more than once during this symposium. It is really not just a buzzword, but also a vision against which we must measure every new product and method. The University of Antwerp and all other presenters in this symposium are suitable partners for this.

Our research group looks back with pride on its close cooperation with the asphalt and bitumen sector, and we look forward to more collaboration in the coming years with much eagerness. And we like to do that together. Hence, 'research meets industry'.

This book is compiled by all abstracts of the presentations of AIS2021.

Have a good reading!

Sincerely,

Prof. Wim Van den bergh, chair

Organizing committee

Prof. Wim Van den bergh

Prof. Cedric Vuye

Dr. Navid Hasheminejad

Ing. Karolien Couscheir

Ing. Geert Jacobs

Scientific committee

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Prof. Johan Blom

Prof. Zhi Cao

Dr. David Hernando

Dr. Seyed Reza Omranian

Dr. Navid Hasheminejad

M.Sc. Georgios Pipintakos

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13:15 to 13:30	Getting acquainted with the Whova platform

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Parallel session 2B (En) - Bitumen: From Chemistry to application Chair: Prof. Dr. Johan Blom and M.Sc. Georgios Pipintakos	
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Parallel session 6B (Du/En) – Sponsor session
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Sponsors
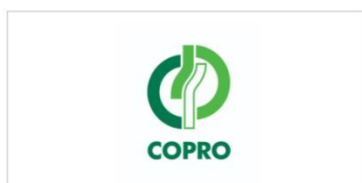
Session 2A:
Collaborative research with EMIB

Sustainable base layer by BSM: First Flemish experiences

Ecem Nur Barisoglu[1*], Hosam Almalehy[1], Karolien Couscheir[1], Frank Theys[2], Wim Van den bergh[1]

[1] Energy and Materials in Infrastructure and Buildings, Faculty of Applied Engineering, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium

[2] Belgian Road Research Center (BRRC), Fokkersdreef 21, 1933, Sterrebeek, Belgium

[*]Corresponding author email: ecemnur.barisoglu@uantwerpen.be

ABSTRACT

Belgium, like many other countries, is looking for cost-effective, sustainable, and environmentally friendly solutions for pavement rehabilitation. Cold recycling of deteriorated pavements using bitumen stabilisation, such as foamed bitumen or bitumen emulsion, appears to be a priority solution for the sustainable future of the road paving industry. However, this technology is still not entirely accepted in the Belgium road industry. Therefore, the presented study focuses on the first Flemish experience by cold recycling with bitumen emulsion and foamed bitumen using 100% reclaimed asphalt pavement (RAP) in the base course of the pavement. The use of RAP in asphalt base structures is a common practice in Flanders (Belgium) that improves the mechanical properties of the mixes and contributes to the environment, as proven by the literature. An effort has been made to assess the performance of bitumen stabilised materials (BSM) in various circumstances in the present research using this innovative technology in Flanders. It is aimed to understand where this technology is applicable in Belgium conditions and what factors can enhance the possibilities of project success. The presented research also covers preliminary laboratory findings that will be simulated on the construction of test tracks where academia meets applied engineering. It is anticipated that this technology will be a competitive option for the Flanders road industry and improve the application in bitumen stabilisation based on the preliminary results.

Keywords: bitumen stabilised materials, cold recycling, reclaimed asphalt pavement, foamed bitumen.

Beyond smart pavements: Multi-functional connected infrastructure

Nizar Lajnef [1*]

Michigan State University, Department of Civil and Environmental Engineering [1]

*Corresponding author email: lajnefni@msu.edu

ABSTRACT

Critical transportation infrastructure such as bridges, roadways, guardrails, and signs will degrade over time from repeated and long-term mechanical usage. Monitoring the details of this usage, over the entire span of the structure, provides critical data that can be used to prioritize structural maintenance thus significantly improving the safety and reducing life-cycle costs. Currently, the most common form of assessing the integrity of a structure is only based on visual inspections. Federal, state, and local governments spend billions of dollars to maintain transportation systems or utilities. Despite these large expenditures, significantly large investments are needed for upgrades and repairs. Existing monitoring techniques primarily focus on evaluating the state of a system at a given instant in time. However, in order to achieve effective management and preservation strategies, the next generation civil infrastructure has to rely on integrated sensing systems that combine the abilities to evaluate and diagnose a structure's state, as well as to prognosticate future performances. These systems should also be able to deliver a long-term continuous stream of monitoring data, as well as implementing self-sensing and other multifunctional abilities. The induced intelligent monitoring would lead to an optimized faster construction, as well as to increased durability and improved performance. Currently there still exists a wide gap between the structural assessment needs and the available technologies.

On the other hand, current autonomous and semi-autonomous technologies are not practical for complex unknown terrains due to lack of training data and due to dynamic driving conditions. As perception and planning systems become more complex, the task of coupling high-resolution sensors, perception algorithms and advanced planning systems incurs a significant increase in computational costs. Furthermore, current sensing and processing modalities suffer a loss of performance under adverse conditions, such as in low light situations or during a period of inclement weather. Integrated innovative multifunctional infrastructure, based on advanced application of remote sensing, communication, and information processing technologies are the way forward in the development of enhanced reliable data collection, analysis, and enhanced reliability autonomous systems.

This presentation provides an overview of the current developments and future challenges toward fully multifunctional infrastructure systems that are in support of advanced reliable communication, autonomous systems, and assessment and management procedures.

Keywords: multifunctional infrastructure, sensing, data analysis

Diving into the latest results from our test tracks in the Port of Antwerp

David Hernando[1*], Karolien Couscheir[1], Geert Jacobs[1], Wim Van den bergh[1], Johan Braspenninckx[2]

[1] Energy and Materials in Infrastructure and Buildings, Faculty of Applied Engineering, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium

[2] Port of Antwerp, Havenhuis, Zaha Hadidplein 1, 2030 Antwerp, Belgium

*Corresponding author email: david.hernando@uantwerpen.be

ABSTRACT

The use of large amounts of recycled materials is today a reality in the paving industry. However, there are still questions about the long term performance of these materials and how the properties measured in the laboratory relate to those later observed in the field. In an attempt to answer these questions, a test track was built at Nieuwe Westweg, in the Port of Antwerp. This test track included two different base materials (crushed stone and lean asphalt), three different asphalt base layers (dense-graded with 50% RAP, dense-graded with 50% RAP and fibers, and high-modulus asphalt mixture with a polymer-modified asphalt binder), and three different surface layers (SMA, dense-graded with a polymer-modified binder, and dense-graded with a conventional binder and fibers). Because of the number of experimental factors considered, this is arguably one of the most comprehensive tests tracks built in Flanders to date. Given the relevance of this test track, all sections were instrumented with fiber Bragg gratings (FBGs) to monitor the strain at multiple depths over time. Additionally, all asphalt mixtures were sampled during construction to measure material properties in the laboratory. A preliminary monitoring campaign conducted with a calibrated truck and a large wheel loader (52 ton) using the embedded FBG sensors showed that the type of base (crushed stone or lean asphalt) had a clear influence on the response of the section. The sections with a crushed stone base exhibited the typical response of a flexible pavement, with a maximum tensile strain over 50 microstrain at the bottom of the asphalt that can potentially induce bottom-up cracking. Conversely, when lean asphalt was used as the base layer, the maximum tensile strain shifted to the bottom of the lean asphalt and was well below 50 microstrain. The low tensile strain levels measured in the sections with lean asphalt suggest that these can potentially be long-life pavements. Regarding laboratory testing, the semicircular bending test was employed to measure the cracking resistance of all mixtures. The SMA mix outperformed all other mixtures, followed by the surface layer with conventional binder and fibers, and the high-modulus base mixture. The results clearly showed that mixtures with softer binders (even in the case of polymer-modified binders) and lower RAP content are more flexible and thus, more resistant to crack propagation. Future research efforts in this test track include a comprehensive monitoring plan to evaluate the change in material properties and pavement section response over time.

Keywords: polymer modified binder, reclaimed asphalt pavement, health monitoring, fiber Bragg grating, cracking.

Session 2B:
Bitumen: From chemistry to application

Influence of filler on the behaviour of mastic in linear amplitude sweep

Miomir Miljković[1*], Mohit Chaudhary[2], Nikhil Saboo[3], Ankit Gupta[4]

[1] University of Niš, Faculty of Civil Engineering and Architecture,
Aleksandra Medvedeva 14, 18000 Niš, Serbia

[2] Indian Institute of Technology (BHU), Department of Civil Engineering, 221005 Varanasi, India

[3] Indian Institute of Technology, Civil Engineering Department, 247667 Roorkee, India

[4] Indian Institute of Technology (BHU), Department of Civil Engineering, 221005 Varanasi, India

[*]Corresponding author email: miomir.miljkovic@outlook.com

ABSTRACT

Fatigue cracking is one of the primary modes of asphalt deterioration and takes place as a consequence of the accumulation of damage induced by a cyclic stress and strain state. Bituminous mastic, as a distinct phase of asphalt mixtures building up the interfacial transitive zone, plays the most important role in the fatigue-related behaviour of asphalt. Nevertheless, there is still little deep understanding of how the interaction between bitumen and filler affect the fatigue response of mastic. The objective of this research was to investigate the influence of the volume fraction and mineralogical composition of filer on the linear amplitude sweep-based fatigue behaviour of bituminous mastic, as a result of the interaction between bitumen and mastic. This objective was pursued by) quantifying the contribution of filler to the evolution of the comprehensive rheomechanical response of mastic during the testing. The experimental programme comprised one red mud filler and two carbonaceous fillers (marble and limestone dust) with the volume fractions of 10, 20, and 30 %. The rheological properties of the mastics within the Linear viscoelastic domain were evaluated by frequency sweep. The fatigue behaviour was determined by the linear amplitude sweep including the pseudo strain energy-based viscoelastic continuum damage analysis of long-term aged specimens at the intermediate temperatures of 5, 15, and 25 °C. The results suggested the existence of a threshold of the volume fraction of filler which was supposed to coincide with the optimum film thickness and the optimum interaction between filler and bitumen. The particle size distribution of filler determined the fatigue behaviour of the mastics as indicated by the dependencies of shear stress amplitude, complex shear modulus, and phase angle. The very fine particle size distribution of red mud filler resulted in the particularly high effect of filler particles on the complex shear modulus of mastic during the accumulation of damage which could be explained by the diffusion of bitumen in mineral particles. On the contrary, temperature played the dominant role in the behaviour of marble and limestone dust filler-based mastics. The results demonstrated the critical need of being able to characterise the mode of failure by some of the evaluated rheological or pseudo energy-based quantities, and thus ensure the target mode of failure.

Keywords: fine aggregate matrix (FAM), fatigue, linear amplitude sweep (LAS), simplified viscoelastic continuum damage (S-VECD), non-linear viscoelasticity (NLVE)

How important are air voids for ageing gradient in asphalt pavements?

Eman L. Omairey[1, 2*], Yuqing Zhang[1], Hilde Soenen[3], and Xavier Carbonneau[4]

[1] Aston Institute of Materials Research, Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom

[2] School of Built Environment, Engineering and Computing, Leeds Beckett University, Queen Square Court, City Campus, Leeds, LS2 8AJ, United Kingdom

[3] Nynas, Groenenborgerlaan 171, 2020 Antwerp, Belgium

[4] Campus for Science and Techniques (CST), COLAS, 4 rue Jean mermoz, 78771 Magny les hameaux, France

[*]Corresponding author email: e.omairey@leedsbeckett.ac.uk

ABSTRACT

Oxidative ageing in field asphalt pavements is a complex process controlled by coupled physical processes, including heat transfer, oxygen diffusion and ageing kinetics together with material morphology. Understanding the impact of each physical process on the ageing evolution is of paramount significance to mitigate ageing and extend the pavement service life. This parametric study uses Multiphysics modelling approaches to predict the field ageing and evaluate the effects of air voids content and distribution and oxygen accessibility on the spatial and temporal evolution of the oxidative ageing in the asphalt pavements. The findings were validated using available literature results and field data from 14 European road sections.

Results suggest that asphalt layers built on unbound granular base (free access to oxygen at asphalt layer bottom) will experience greater overall ageing with a C-shaped ageing gradient compared to that built on treated base (no access to oxygen at the bottom) which lead to a r-shaped ageing gradient. The air void content plays a vital role in limiting oxidative ageing. Dense asphalt pavements with a low air voids content (< 5%) experience little to no ageing, whereas asphalt pavements with air void content of 5-9% experience a growing oxidative ageing rate with an increasing air void content. Pavements with high air voids (> 9%) will have full access to oxygen from the atmosphere, thus the average carbonyl content is high and uniform across asphalt pavement depth with no clear C-shaped or r-shaped ageing gradient. With the same overall air voids content, a C-shaped distributed air voids along the depth causes a slightly more ageing than that of uniformly distributed air voids. Finally, ageing data from 14 European road sections were used to validate the findings, including the C-shaped and r-shaped ageing gradients and the air void content threshold of (5~9%) separating the limited, gradually increasing, and high ageing in the asphalt layers.

Keywords: Asphalt Pavements, Oxidative Ageing, Parametric Analysis, Air Voids Content, Ageing Gradient.

Coupling AFM and CLSM to investigate the effect of ageing on the bee structures of bitumen

Georgios Pipintakos[1*], Johan Blom[1], Hilde Soenen[2], Wim Van den bergh[1]

[1] University of Antwerp, EMIB Research Group, Groenenborgerlaan 171, Antwerp 2020, Belgium

[2] Nynas NV, Groenenborgerlaan 171, Antwerp 2020, Belgium

*Corresponding author email: georgios.pipintakos@uantwerpen.be

ABSTRACT

Bitumen's surface microstructure is in general well-documented and most recent theories postulate the effect of crystalline wax on the so-called bee structures. Although it is widely accepted that ageing has an effect on this unique microstructure yet conflicting literature exists on clear trends. This paper explores the effect of ageing on the bee structures of bitumen, employing two advanced microscopic techniques: an Atomic Force Microscopy (AFM) and a Confocal Laser Scanning Microscopy (CLSM). Four waxy and two wax-free bituminous binders are investigated before and after sequential laboratory short- and long-term ageing. The study demonstrates that the number of bees per μm^2 and bee area percentage decrease with ageing, whereas their size is increasing. A systematic analysis of the waveform characteristics is also provided for the peaks and valleys as well as the shape probabilistic values of the bee structures. In conclusion, the results of the two techniques are in good agreement, reporting similar trends upon ageing for the relative bee density. Differences are mainly identified in the waveform calculations. It is believed that this systematic investigation may assist in enhancing the understanding of the effect of ageing on the surface microstructure, the wax distribution as well as on the wax crystallisation.

Keywords: Bitumen, AFM, CLSM, Ageing, Bee structures

Quantified chemical fingerprinting and real-time oxidation dynamics of asphalt binders using Vocus Proton Transfer Reaction (PTR-TOF) mass spectrometry

Anand Sreeram[1*], Daniel Bloomdahl[1], Pawel Misztal[1], Amit Bhasin[1]

[1] Department of Civil, Architectural and Environmental Engineering,
University of Texas at Austin, Texas, USA

[*]Corresponding author email: anand.sreeram@austin.utexas.edu

ABSTRACT

Asphalt binders are complicated mixtures whose exact chemical and molecular composition is variable and has not been fully grasped to date. Understanding the building blocks of binders is critical in elucidating its important chemo-mechanical characteristics including the process of chemical transformations during oxidative aging. Advancement in this area requires the use of novel techniques and approaches than those explored so far. This study investigated the use of the Vocus PTR-TOF mass spectrometer for the high resolution chemical fingerprinting of asphalt binders along with the observation of their real-time oxidation dynamics. Three different binders were selected to examine the sensitivity of this technique under different gas blankets namely nitrogen, VOC free air and ozone enriched air. Various experimental setups using metal and non-metal contact surfaces were also used to characterize any potential intermediary signatures that were potentially formed during the oxidation process. The results of the experimental procedures indicated that higher intensities of molecules could be observed under the ozone enriched blanket indicating that this environment could be richer for oxygen containing species and oxidative products formed. Additionally, hierarchical clustering revealed differences in the degree of chemical expression of various molecules in the different binders which could be attributed to their unique primary differences, illustrating the fingerprinting technique. The results could be used to identify the similar and dissimilar groups of different asphalt binder compounds detected during the experimental process. Lastly, the real time oxidation characteristics of binders were observed through positive matrix factorization (PMF) analysis which elucidated possible pathways for binder oxidation, for example, through benzylic routes. Overall, the work conducted in this study points to the remarkable potential of this analytical technique to fingerprint asphalt binders at a high time and chemical resolution and provides promising results for further work towards building a database of chemical fingerprints and relating this to macro-level properties.

Keywords: asphalt aging, Vocus PTR-TOF, asphalt oxidation, PMF analysis, asphalt binder chemistry.

Session 3A:
Digitalization and sustainability

Digital twining of pavements: Application for training, construction and innovation

Faridaddin Vahdatikhaki[1*], Seirgei Miller[1]

[1] Construction Management and Engineering Group, Department of Civil Engineering, University of Twente, the Netherlands

[*]Corresponding author email: f.vahdatikhaki.utwente

ABSTRACT

Some may argue Digital Twin (DT) is just another buzzword of the day in the construction industry. Yet, it is undeniable that the industry is overwhelmed by the data generated by the use of new digital technologies. An unstructured, fragmented, and decentralized approach towards the storage and use of these data is shown to have cast a thick shadow on the usefulness of digital technologies over the past few years. Consequently, despite the sharp increase in the adoption of new technologies in the pavement domain, improvements in construction processes and products are slow. In the authors' view, DT is an effort to orchestrate these digital technologies towards establishing a unified system committed to enhancing decision-making across the entire lifecycle. Encompassing visualization, simulation, sensing, and data analytics technologies, DT has a great potential to disrupt the industry. Asphalt Paving, Research & Innovation (ASPARi) has had several initiatives to leverage the DT concept for the construction, training, and technology development of road pavement over the past few years. We have successfully used data collected during the construction phase to support equipment operators, machine manufacturers/system developers, and training schools. In this presentation, we would like to present some of these initiatives and discuss our take on the road ahead toward the lifecycle digital twinning of road pavement.

Keywords: Digital Twin, Digital Technologies, Pavement, ASPARi

Leaching characteristics of permeable pavement materials and the influence on urban road runoff

Jiawen Liu[1], Hui Li[1*], Bing Yang[1], Jie Yang[1]

[1] Key Laboratory of Road and Traffic Engineering of the Ministry of Education
College of Transportation Engineering, Tongji University

[*]Corresponding author email: hli@tongji.edu.cn

ABSTRACT

Permeable pavement allows water to pass inside the material, therefore some components of the material will inevitably be taken away during infiltration. Currently, studies mainly focus on the mechanical properties of permeable pavement materials and their ecological characteristics such as permeability, cooling effects, etc., while less attention is paid to whether they will have a potential impact on the surrounding water environment. Especially in recent years, recycled solid waste materials and biomass materials have gradually been applied in permeable pavement. For waste rubber, red mud and other solid waste materials containing heavy metals and bio-based materials rich in nitrogen and phosphorus pollutants such as biochar, more research on their leaching risks in permeable pavement materials is needed. Based on the immersion tests under different conditions, this study investigated the leaching characteristics of permeable pavement materials (PP) and PP with rice straw biochar fillers. Their influence on urban road runoff and aquatic organisms was further tested through the zebrafish acute biological toxicity test. The results showed that when infiltrated by surface water, certain amount of total nitrogen (TN) and total phosphorus (TP) could be leached, some of these nitrogen and phosphorus pollutants came from biochar fillers and some from the bitumen material itself. The results of the immersion test of permeable pavement specimens showed that when infiltrated by surface water, the concentration of leaching pollutants of PP were within the limit of the environmental quality standards for surface water, and the survival rates of the zebrafish were relatively high. However, the longer soaking time and acidic extractant aggravated the leaching of nitrogen and phosphorus pollutants in permeable pavement materials, which might cause potential hazards. The method of zebrafish acute biological toxicity test could also provide a reference for quick and efficient testing and visual characterization of environmental friendliness of pavement materials.

Keywords: permeable pavement materials, leaching characteristics, biochar, zebrafish aquatic toxicity

Asphalt 4.0, the big challenge of the digital transformation of paving activity

Dr. Potti, Juan José

Association of Manufacturers of Asphalt Mixtures − Asefma

President of EAPA

ABSTRACT

Digital transformation of road paving refers to a series of smart and autonomous systems fueled by big data, machine learning, artificial intelligence, blockchain, internet of things (IoT), etc.. with capacity to significantly push forward the efficiency, productivity, quality, reliability and sustainability of asphalt roads. The application of these technologies to the asphalt paving sector is known as **Asphalt 4.0**. This involves the use of digital tools to automate, monitor and improve the way, in which organisations develop conventional activities, such as management of asphalt plants, manufacturing of bituminous mixtures, transport/supply or installation (e.g. laying, compaction, etc).

Through the use of digital technology, the organisation can improve the way in which it develops its activity, to help those working in it. In addition, it also facilitates and accelerates the transition of the mobility sector towards its new users, such as the electric and automated vehicles.

The development of the Asphalt 4.0 concept affects all areas of the organisation and for this reason it should be directed at the highest level. The concept is based on three pillars:

Digital technologies and tools for the safe, effective and efficient data management, which includes its generation, storage and transfer. Some examples are the cloud storage, internet of things (IoT), virtual and augmented reality, blockchain, artificial intelligence, machine-to-machine (M2M) communication systems, advanced sensors, autonomous robots or cybersecurity protocols.

Smart management systems able to process all data obtained and identify patterns, which will lead to optimum decision making and in a timeframe, which would not be reasonably feasible for humans. Some examples are the digital business management, digital talent management, digital innovation management, digital sales management and digital project management

Customer experience. The consequence of previous technologies is a dynamic production system, which is constantly adopting innovations and readapting to maximise the customer satisfaction. Roads are not just delivered after construction, but monitored, managed and maintained based on the instant information that is being received and the resulting optimum strategy. Some examples are digital marketing, e-commerce, customer service, customer intelligence and user experience

Keywords: Asphalt 4.0, digital transformation, paving, asphalt, digitalization.

Advances in the state-of-practice of asphalt mixture LCA: Towards net zero

Amlan Mukherjee[1*], Joseph Shacat[2]

[1] Department of Civil, Environmental & Geospatial Engineering, Michigan Tech University[1]

[2] Director of Sustainable Pavements, National Asphalt Pavement Association[2]

[*]Corresponding author email: amlan@mtu.edu

ABSTRACT

The objective of this paper is to report on the lessons learned and advances implemented in conducting the Life Cycle Assessment (LCA) of asphalt mixtures that supports the National Asphalt Pavement Association's Emerald Eco-Label Environmental Product Declaration (EPD) program. The paper also identifies data and methodological knowledge gaps that need to be addressed to support a pathway to achieving Net-Zero. The EPD program continued its emphasis on using publicly sourced open datasets to ensure transparency. The background data sets used for electricity, transportation and fossil fuels were updated to reflect the most recent inventories available through the Federal LCA Commons platforms. Specifically, the electricity inventories sourced from the US Department of Energy are a significant improvement as they provide regionalization at the balancing authority level for consumed electricity. In another technological advance, the LCA adopted a digital implementation of life cycle information models (LCIM) using the OpenLCA platform (Bhat et al. 2021). LCIMs are parameterized relational data structures that can be used to represent the input-output relationships in the LCA model, encode prescribed background inventories, and include well-defined parameters that encode foreground data. The use of LCIMs ensures the reliability and open access of the underlying LCA models and enables their use as plug-in building blocks in LCA of systems that use asphalt mixtures as an input. Substantively, the LCA included analysis on variations in estimated Global Warming Potential (GWP) and cumulative energy demand metrics for different mix designs, use of recycled materials, energy sources used, and transportation haul distances. An estimation of impacts for portable asphalt plants was also included. The LCA shed light on current gaps in knowledge and methodology with respect to accounting for biogenic carbon, use of carbon offsets and ways of including/reporting renewable energy certificates. As the market for renewable, bio-based primary and secondary fuels expands in the United States, there will also be a need to develop appropriately regionalized inventories for their use in the asphalt LCA. The paper will consider these topics in the context of potential system boundary expansions and assessment of avoided burden when using asphalt mixtures to identify a pathway towards Net Zero.

Keywords: LCA, EPD, Net-Zero, Biogenic carbon, Information models

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Session 3B:
Challenging the performance of asphalt pavements I

Application of nano/microparticles on asphalt mixes to promote photocatalysis and superhydrophobicity

Iran Rocha Segundo[1,2*], Elisabete Freitas[3], and Joaquim Carneiro[2]

[1] University of Minho, CTAC, Department of Civil Engineering, Guimarães, Portugal

[2] Centre of Physics of Minho and Porto Universities (CF-UM-UP), University of Minho, Azurém Campus, Guimarães, Portugal

[3] ISISE, Department of Civil Engineering, University of Minho, Guimarães, Portugal

*Corresponding author email: iran_gomes@hotmail.com

ABSTRACT

The integration of nano/microparticles in asphalt mixtures provides new capabilities (functionalization) such as: photocatalytic; superhydrophobic and self-cleaning, which can contribute to the mitigation of present public health problems as air pollution and road safety. Thus, the main goal of this research was to develop these capabilities on asphalt mixtures composed of raw and recycled materials and analyze the performance of an improved functionalization process using a resin spraying for the immobilization of the particles. Solutions composed of nanoparticles of titanium dioxide (nano-TiO_2) and/or microparticles of polytetrafluoroethylene (micro-PTFE) and water, ethyl alcohol, and dimethyl ketone as solvents were produced and subsequently sprayed over a conventional AC 10. The best solution (BS) to proceed with the functionalization process was selected after the evaluation of the samples under dye degradation and wettability. Next, two successive spraying coatings were carried out over conventional and recycled AC 10 with Reclaimed Asphalt Pavement (RAP) and Steel Slags (SS): the first one with a diluted epoxy resin and the second one with the BS. In the first step of the functionalization process, the BS selected was composed of TiO_2 (4 g/L) and PTFE (4 g/L) under an ethyl alcohol medium. The next steps showed that by increasing the amounts of resin, the photocatalytic efficiency decreases and the wettability increases, performing better for 0.25 g of resin with BS. All the mixtures achieved the superhydrophobicity property (water contact angle higher than 150°) and performed similarly regarding wettability with the lowest resin amount. Nevertheless, the conventional AC 10 presented the best results concerning photocatalysis. These functionalized pavement surfaces can degrade gases like SO_2 and NO_x, avoid accidents by removing the small dirt particles, degrade oils on the pavement surface, presenting great benefits to road safety and the environment. Multifunctional asphalt mixtures can be included in the sphere of Clean Technologies, and, in this framework, they contribute to the transition to the sustainable model "Green Recovery". Moreover, this research presents a potential destination for the nano/micromaterials, the Civil Engineering fields, and, if incorporated on a large scale, can stimulate the dynamism of industry.

Keywords: smart asphalt mixtures, photocatalytic asphalt mixtures, superhydrophobic asphalt mixtures, functionalization process, sustainable road pavements.

Development and testing of encapsulated oil as an additive to prevent asphalt ravelling. preliminary results

Garcia A.[1*], Traseira L.[1], Ruiz-Riancho I.[1], Abedraba, M.[1], Haughey, F.[2]

[1] Nottingham Transportation Engineering Centre, Faculty of Engineering, University of Nottingham, Nottingham NG7 2RD, United Kingdom

[2] Tarmac-A CRH Company, Bickenhill Lane, Portland House, Solihull, B37 7BQ

[*]Corresponding author email: alvaro.garcia@nottingham.ac.uk

ABSTRACT

We have encapsulated sunflower oil in calcium alginate and mixed these capsules as an additive in asphalt. We aim to validate that the capsules delay stone loss and reflective cracking of asphalt. The capsules are approximately spherical and, their diameters ranged from 1 to 2 mm. Their composition included approximately 60% of oil, 20 % alginate, and 10 % of limestone filler that we used to coat them. We chose to produce them using the ionic gelation method because it allows manufacturing them at ambient temperature. In this method, an emulsion of oil, water, and alginate is prepared and dropped into a calcium chloride solution. The capsules have an internal closed porous structure containing the oil and protecting it during asphalt mixing and compaction.

We have tested the capsules performance in stone mastic asphalt, with 10 mm and 20 mm maximum aggregate size, since this is the mixture commonly used for wearing surfaces in the UK. To produce the best possible results using a laboratory mixer and an asphalt plant, 0.5 % of capsules by mass of total mixture were mixed in the asphalt with the aggregates, at approximately 160°C, seconds before bitumen was added and, the total mixing time was approximately 30 seconds. We found that the mixing time for the capsules strongly influenced how they improved the stone loss resistance of asphalt.

Asphalt has been manufactured in the laboratory and compacted using a rolling wheel compactor to create slabs that have been used to test rutting. Furthermore, cores have been cut from the slabs and used to test the stone loss resistance of asphalt. In addition, a test section of 5 m x 7 m has been built at the University of Nottingham's Accelerated Pavement Testing Facility and, in November 2021, 8 test sections of stone mastic asphalt, with different amounts of bitumen were built at a quarry in the UK. No data of the test sections is yet available.

It has been found that capsules progressively deform and release the oil with the continuous passing of vehicles. This causes that after several thousand cycles in a Hamburg Wheel tracker, rutting increases by a fraction of a millimetre. Moreover, we found that stone loss is delayed by approximately 20% and reflective cracking by approximately 5%. Although the working mechanism of capsules is still unclear, the authors are convinced that it is related to the deformation of the capsules.

Keywords: Capsules, oil, stone loos, rutting, reflective cracking.

Viscoelastic property predictions of crumb rubber modified bitumen using micromechanics models

Haopeng Wang[1,2*], Xueyan Liu[2], Sandra Erkens[2], Tom Scarpas[2], Gordon D. Airey[1]

[1] Nottingham Transportation Engineering Centre, University of Nottingham, Nottingham, UK

[2] Section of Pavement Engineering, Faculty of Civil Engineering & Geosciences, Delft University of Technology, Delft, The Netherlands

[*]Corresponding author email: haopeng.wang@tudelft.nl

ABSTRACT

Crumb rubber modified bitumen (CRMB) can be regarded as a binary composite system in which swollen rubber particles are embedded in the bitumen matrix. Previous study has successfully implemented the micromechanics models in predicting the complex moduli of CRMB binders using more representative constituent parameters. In the regime of master curves, while the used micromechanics models predicted well in the high-frequency range, they underestimated the complex modulus in the low-frequency range. The current study aims to further improve the prediction accuracy of micromechanics models for CRMB by considering the interparticle interactions. To accomplish this goal, a new reinforcement mechanism called chain entanglement effect was introduced to account for the interparticle interaction effect. Results show that the polymer chain entanglement effect accounts for the underestimation of complex modulus and lack of elasticity (overestimation of phase angle) for CRMB at high temperatures/low frequencies. The mechanical properties of bitumen matrix and entangled polymer network can be determined based on the rubber content. The introduction of the entangled polymer network to the generalized self-consistent (GSC) model significantly improved the prediction accuracy for both complex modulus and phase angle in the whole frequency range. In summary, by incorporating the physio-chemical interaction mechanism into the currently available models, a new dedicated micromechanics model for predicting the mechanical properties of CRMB has been developed. The predicted viscoelastic behavior can thereafter be used as inputs for an improved mix design.

Keywords: Crumb rubber modified bitumen; micromechanics; viscoelasticity; generalized self-consistent model; polymer network; chain entanglement

A multi-criteria decision-making model to rank recycled plastic-modified bituminous blends considering laboratory performance and environmental impact indicators

João Santos[1*], Filippo Giustozzi[2]

[1] Department of Construction Management and Engineering Department, University of Twente, The Netherlands

[2] STEM| School of Engineering, Royal Melbourne Institute of Technology (RMIT), Australia

[*]Corresponding author email: j.m.oliveiradossantos@utwente.nl

ABSTRACT

In an attempt to embrace sustainability principles in its practices, the road paving sector is increasingly using recycled materials as pavement materials. Within this context, the use of plastic recyclates for bitumen modifications has received considerable attention from multiple societal sectors. However, not rarely, generic claims about the sustainability of such materials are made without fully considering their performance. The potential environmental impacts of various alternative materials can be quantified by means of the Life Cycle Assessment (LCA) methodology while many performance indicators can be determined through laboratory and field tests. Nevertheless, it is highly uncommon for these two approaches to be combined in the same decision support system. Trading off between environmental impacts and durability in the field is considered of paramount importance when evaluating alternative road paving materials, especially when used in large projects.

This presentation introduces the development of a multi-criteria decision-making (MCDM) model to rank recycled plastic-modified bituminous blends based on their techno-environmental performance. It comprises three main steps: 1) assessment of the laboratory performance of the bituminous blends; 2) assessment of the potential environmental impacts of the bituminous blends; and 3) ranking of the bituminous blends based on the grey relational analysis (GRA) theory. This methodology is not only capable of differentiating alternatives for road pavement engineering applications from a multi-criteria perspective, but, also, proved to be robust to a great extent to methodological choices. Hence, it can be easily adjusted to many other recycled materials for road pavement engineering applications and/or several additional performance and environmental indicators as well as economic and/or social ones.

Keywords: asphalt, recycled waste plastic, life cycle assessment (LCA), multi-criteria decision making, grey relational analysis (GRA).

Session 4:
Innovation in Road Engineering Research and Industry

The strategy towards sustainability in asphalt industry 4.0

Breixo Gomez-Meijide[1*]

1 European Asphalt Pavement Association (EAPA)

*Corresponding author email: breixo@eapa.org

ABSTRACT

With documents, such as the European Green Deal, the new Circular Economy Action Plan or the 2030 Digital Compass, the European Commission has recently stablished challenging objectives in terms of Sustainability and Digitalisation, as well as a series of priority actions for the European agenda of the coming decades. This presentation gives an overview on how the European Asphalt Industry is responding to the challenge, through concepts, such as circular economy (i.e. re-use and recycling), low-temperature asphalt, extended pavements durability, reduction of vehicles emissions, decarbonisation of the supply chain and the application of a wide range of digital solutions through every stage of the asphalt paving process, also known as "Asphalt 4.0". How these technologies can facilitate the arrival of new road users (e.g. electric and autonomous vehicles), as well as potential risks that these vehicles may produce on the durability of the pavements, are also explained.

Bitumen ageing and the fountain of youth – a dream or reality

Johannes Mirwald[1*], Bernhard Hofko[1]

[1] Christian Doppler Laboratory for Chemo-Mechanical Analysis of Bituminous Materials, Institute of Transportation, TU Wien, Gusshausstrasse 28/E230-3, 1040 Vienna, Austria

[*]Corresponding author email: Johannes.mirwald@tuwien.ac.at

ABSTRACT

The durability and life time of an asphalt pavement is usually determined by the binder's quality. Since bitumen is an organic material, it is more prone to oxidation under atmospheric conditions compared to inorganic materials like the aggregates of filler. Thus, its changes during its life time are crucial for the asphalt performance in the long run. To better understand the parameters affecting the bitumen ageing process various laboratory ageing simulations are applied. While thermal ageing applied by the pressure ageing vessel (PAV) dominates the international bitumen research community, other factors like photo-oxidation by UV-vis light or chemical ageing by reactive oxygen species have been addressed and implemented lately. Since all of these factors contribute to field ageing, their respective single and combined contributions need to be understood on the chemical and mechanical level. This can be achieved by combining state of the art rheological testing using a dynamic shear rheometer (DSR) with spectroscopic analysis like Fourier-Transform-Infrared (FTIR) spectroscopy. Linking these techniques to a chemo-mechanical correlation, a simplified overview shows that sole thermal ageing is not adequate to meet field ageing behavior, while a combination of thermal and chemical ageing can get close to it. Furthermore, the impact of UV-vis light shows that the photo-energy of the light can have a significant impact on the oxidation products formed during the ageing process. After accessing the impact of the respective ageing factors the question of rejuvenation versus regeneration can be addressed. Since bitumen oxidation is an irreversible process where an incorporation of oxygen is occurring, actual rejuvenation would require a lot of energy to remove the oxygen from the material. However, restoring the materials properties to a certain level by regeneration is much more likely to be implemented in the small and large scale. While there are many materials available on the market which are labelled as rejuvenators, their effect on the binder is usually linked to a softening or regenerating effect, as the oxygen remains in the material after all. Therefore, in order to properly restore the materials performance a thorough assessment on the macro and molecular level are necessary to prevent simple re-softening of the material on a short-term level basis and be able to comprehensively restore the binder's properties for better long-term performance.

Keywords: Bitumen Ageing, Thermal, Chemical, UV-vis light, Rejuvenation, Regeneration

University of Antwerp
EMIB | Energy and Materials
in Infrastructure and Buildings

Ongoing research and needs for next generation pavements

Emmanuel Chailleux[1*], Pierre Hornych[1]

[1] University Gustave Eiffel

[*]Corresponding author email: Emmanuel.chailleux@univ-eiffel.fr

ABSTRACT

Pavement related research has to consider the legacy of the past as well as present and future constraints. Especially, in countries with well-developed road networks, the main concern is to be able to propose solutions to efficiently rehabilitate pavement surfaces and/or structures and finally to adapt transportation infrastructures to new mobility uses. It is mainly environmental constrains that will have to guide these efforts. First, global warming concerns push us to find solutions to reduce CO_2 emissions while preserving mobility needs. Secondly, consumption of non-renewable materials needs to be reduced to preserve next generation building potential. Considering both criteria, life cycle analysis applied to road construction shows that first order actions are to recycle reclaimed asphalt, to reduce material transportation distances and to optimize pavement durability. Moreover, new policies concerning heat engine vehicle restrictions lead us to serious thinking about transportation infrastructure adaptation to electric mobility.

To reduce non-renewable material uses, researches at university Gustave Eiffel focus on increasing reclaimed asphalt recycling rate as well as bio-binder development. A synergetic solution has been explored is the BioRePavation project where high recycling rate without bitumen addition has been successfully tested at full scale. Other long-term researches are conducted to find a process to transform biomass into bio-binder and bio-additive (Algoroute and Bitume 2.0 projects).

To reduce manufacturing energy consumption "cold" solutions with emulsion-based asphalt mixes are studied. In order to achieve this goal, research mainly focuses on a better understanding of curing mechanisms. Another solution explored at University Gustave Eiffel, is the possibility to build positive energy pavements. Using the pavement surface as heat exchanger and a support for photovoltaic panels, it would be possible to compensate energy needed for construction by producing energy.

To optimize pavement durability, it is necessary to improve both pavement performance models and monitoring methods. In this field, University Gustave Eiffel is leading the French national research project MOVEDVDC, which aim is to develop improved methods to evaluate residual life of asphalt materials. It also works on the development of efficient and low cost sensors for remote monitoring of pavement response.

To adapt transportation infrastructure to electric mobility, University Gustave Eiffel is working on solutions of Electric Road Systems (ERS), for dynamic charging of electric vehicles by the road. The integration of such charging systems in pavements raises many challenges, in terms of resistance to traffic, durability, safety and maintenance. These studies show that the road structure itself is an essential element of such systems, and plays a key role in their successful development.

Keywords: recycling, cold mixes, bio-binders, energy harvesting, remote monitoring, electric road systems.

Session 5A:
Innovaties van de Vlaamse Asfaltsector

Haven van Antwerpen zet in op ROAD_IT tools: een eerste evaluatie

Johan Braspenninckx[1*], Bart De Beule[1]

[1] Port of Antwerp, Havenhuis, Zaha Hadidplein 1, 2030 Antwerp, Belgium

[*]Corresponding author email: Johan.Braspenninckx@portofantwerp.com

ABSTRACT

Van 2015 tot 2017 liep het Tetraproject over "ROAD IT" (Tetraproject IWT150166 "ROAD_IT: Efficiënt procesbeheer door het intelligent inzetten van IT in de asfaltwegenbouw). Het project leidde tot de demonstratie van het gebruik van IT-tools om het asfaltproces, gaande van productie- en verwerkingsdata, in situ evaluatie, te optimaliseren en consultatie van deze gegevens op langere termijn mogelijk te maken. Er was echter na afloop van het project geen duidelijke visie op het beheer van een globaal IT-systeem.

Het havenbedrijf heeft daarop, vanuit haar eigen visie om een sterke focus te leggen op innovatie en digitalisering, enkele principes vanuit ROAD IT geïmplementeerd in zijn opdrachten sinds 2018. Ondertussen zijn we enkele jaren verder en heeft het nut van dergelijke ROAD IT tools zich ook voor ons als opdrachtgever meermaals bewezen. Het gebruik van enkele aspecten van ROAD IT is dan ook standaard geworden in onze bestekken waar nu ook een bonus/malus aspect aan gekoppeld is afhankelijk van de geleverde kwaliteit.

Het blijkt echter nog steeds voor aannemers vaak een nieuw gegeven om met deze IT – tools te werken en deze ook goed te implementeren om de geleverde kwaliteit te verbeteren. Er wordt dan ook aan de hand van voorbeelden geduid wat precies de effecten zijn op de bonus/malus van bepaalde aspecten van de uitvoering. Er wordt ook ingegaan op de toekomst visie van het havenbedrijf met betrekking tot deze IT – tools en de lessons learned als opdrachtgever van het "ROAD IT" systeem.

Efficiënte asfaltproductie binnen handbereik

Kris Mallefroy[1*]

[1] Afdelingshoofd Asfalt Stadsbader

[*]Kris.mallefroy@stadsbader.com

Efficiënte en milieuvriendelijke asfaltproductie is de toekomst van onze asfaltsector

Om de milieu-impact van onze nieuw op te richten asfaltcentrale te verlagen en om ruimschoots aan de strenge vergunningsvoorwaarden die werden opgelegd te voldoen, werden een heel aantal milieuvriendelijke technieken voorzien bij de bouw van onze nieuwe asfaltcentrale te Grobbendonk.

Naast deze milieuvriendelijke technieken zijn er ook een aantal organisatorische maatregelen die in onze asfaltcentrale werden geïmplementeerd ter voorkoming of beperking van milieuhinder, hierbij een overzicht van de technieken en maatregelen die besproken zullen worden.

- Aanvoer en voorbehandeling van grondstoffen
- Opslag van grondstoffen en stofbestrijding op terrein
- Technieken met betrekking tot energieverbruik en energie-efficiëntie
    - Productie AVT-mengsel met schuimbitumen
    - Koude toevoeging recupmateriaal bij beperkt % toevoeging
    - Warme toevoeging recupmateriaal bij hoger % toevoeging
- Technieken met betrekking tot verwarming recyclage in trommel met hetegasgenerator
- Recirculatie van de rookgassen recuptrommel
- Naverbranding in primaire van afzuiging lucht laadpunt vrachtwagens
- Verhoogde schoorsteen
- ….

Nieuwe Westweg: een living lab voor toekomstige asfaltverhardingen

Wim Van den bergh[1*], Karolien Couscheir[1], Geert Jacobs[1], David Hernando[1*], Johan Braspenninckx[2]

[1] Energy and Materials in Infrastructure and Buildings, Faculty of Applied Engineering, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium

[2] Port of Antwerp, Havenhuis, Zaha Hadidplein 1, 2030 Antwerp, Belgium

*Corresponding author email: Wim.Vandenbergh@uantwerpen.be

ABSTRACT

Innovaties in het laboratorium hebben meer kans om snel door te stromen naar een toepassing wanneer ze gedemonstreerd worden. Samen met de haven van Antwerpen en de aannemer Colas Belgium werden proefvakken aangelegd bij de bouw van de Nieuwe Westweg waarbij verschillende nieuwe technologische innovaties werden gebruikt. UAntwerpen stond in voor de selectie van deze innovaties en de opvolging. Bij het ontwerp van zowel de structuren als de mengsels, wordt uitgegaan van een referentie en een verbeterde, geoptimaliseerde toepassing. Het verkeer over het gehele testtraject wordt als homogeen beschouwd.

Het proefvak bevat twee verschillende funderingsmaterialen (ongebonden steenslag en schraalasfalt – lean asphalt), drie verschillende asfaltonderlagen (APO met 50% AG, APO 50% AG met vezels, AVS met een polymeer-gemodificeerd bindmiddel), drie verschillende toplagen (SMA, APT met een polymeer-gemodificeerd bindmiddel, APT met een conventioneel bindmiddel en vezels). Daarnaast zijn alle secties geïnstrumenteerd met fiber Bragg sensoren (FBGs). Deze FBGs laten toe om de rek op meerdere dieptes in elke structuur in de tijd te monitoren. De asfaltmengsels werden bemonsterd en getest in het laboratorium; stijfheid en scheurgevoeligheid werden met een nieuwe proefopstelling getest. Er wordt de komende jaren een correlatie gelegd tussen veroudering on site en in het laboratorium. De eerste testen op het proefvak zijn uitgevoerd.

De globale doelstelling van dit proefvak is om deze innovaties periodiek te monitoren opdat de prestaties ervan, de duurzaamheidsparameters, in de loop van de tijd kunnen gekwantificeerd worden. De Fibre bragg grating sensoren geven een actualisatie van de staat van de structuur en het gedrag bij belasting onder invloed van tijd, veroudering en opgelopen schade. Hieruit kan op termijn een gedragsmodel opgesteld worden voor zwaarbelaste wegen. In deze bijdrage wordt een overzicht gegeven van de eerste resultaten en de toekomstige meetcampagne.

Keywords: asfaltmengsels, innovatie, proefvak, vezelversterkt asfalt, recycling, polymeerbitumen, sensoren, lean asphalt.

Impact schommelingen AG bij hergebruik:
gevoeligheidsstudie a.d.h.v. PradoWeb en prestatieproeven

Tine Tanghe[1*], Stefan Vansteenkiste[1], Ann Vanelstraete[1]

[1] Belgian Road Research Center[1] (BRRC)

[*]Corresponding author email: t.tanghe@brrc.be

ABSTRACT

In België wordt recyclage al meer dan 40 jaar succesvol toegepast en is de beheersing van de asfaltrecyclage-technologie gestadig gegroeid, alsook de kennis en de beheersing van het asfaltgranulaat (AG) zelf. Zo werden op Europees (EN 13108-8) en Belgisch niveau voorschriften uitgewerkt. Een steeds hoger percentage aan AG kon aldus worden aangewend, en dit in de eerste plaats voor asfaltonderlagen. De toepassing van AG in toplagen is op dit ogenblik echter beperkt: tot maximaal 20% AG bij de laagste bouwklassen B9-B10.

Het ontbreekt momenteel de wegbeheerder aan voldoende vertrouwen m.b.t. de duurzaamheid, en dus garanties op een afdoende levensduur van de asfaltverharding, om het hergebruik van AG in mengsels voor toplagen voor hogere bouwklassen te faciliteren. Nochtans is de asfaltsector vragende partij om het toepassingsdomein van het hergebruik van AG verder uit te breiden naar mengsels van het type APT-C (Asfalt met Prestatie-eisen voor Toplagen) en dit omwille van het grote economisch belang en het streven naar een circulaire economie. Eén van de cruciale elementen om het duurzaam hergebruik van AG in APT-C mengsels mogelijk te maken is gerelateerd tot de beheersing van het AG. Dit is rechtstreeks gelinkt met de AG-kenmerken en de overeenkomstige toleranties. Immers, schommelingen in de tijd van deze kenmerken kunnen een mogelijke impact hebben op de prestaties van asfaltmengsels met AG.

Om op deze vragen een antwoord te kunnen bieden, werd binnen het kader van het Re-RACE project (Rejuvenation of Reclaimed Asphalt in a Circular Economy) in 2020 de OCW-stuurgroep 'Steering Committee Reclaimed Asphalt' opgericht, waaraan vertegenwoordigers van de belangrijkste actoren van de wegenbouwsector actief deelnemen. Recent focuste deze stuurgroep op het opzetten en uitvoeren van een uitgebreide gevoeligheidsstudie, gebaseerd op de praktijk in België. De impact van schommelingen in AG-kenmerken zoals het bindmiddelgehalte, de residuele pen-waarde van het oud bindmiddel, de korrelverdeling en de holle ruimte Rigden van de vulstof, werd in eerste stap onderzocht a.d.h.v. theoretische berekeningen met PradoWeb voor (extreme) APT-C varianten met een percentage aan AG variërend tussen 0% (=referentie) en 50%. Vervolgens werd voor een beperkt aantal APT-C varianten het effect van AG schommelingen ook geëvalueerd a.d.h.v. prestatieproeven zoals de bepaling van de dichtheid en de holle ruimte met de gyratorverdichting, de bepaling van de watergevoeligheid, de weerstand tegen permanente vervorming (spoorvorming) en de weerstand tegen rafeling. De presentatie licht de voornaamste resultaten van deze gevoeligheidsstudie toe.

Keywords: Circulaire economie, hergebruik, asfaltgranulaat, PradoWeb , gevoeligheidsstudie.

Session 5B:
Innovative studies on virgin and modified bitumen

New insights for the bee structures of bitumen

Johan Blom[1*]

[1] Energy and Materials in Infrastructure and Buildings, Faculty of Applied Engineering, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium

[*]Corresponding author email: johan.blom@uantwerpen.be

ABSTRACT

Bitumen is a complex mixture whose composition–structure-property relationships are not well-understood. Therefore, it is essential to understand which components may develop microstructures, how and when these features appear, and if they are initiated or influenced by other components. Many studies have reported so-called bee structures as well as other phases on bitumen surfaces. A large number of observations point towards the crystallinity of waxy compounds as an explanation for the bees. However, doubt remains about the origin of the other phases and the possibility of other bitumen components as promoters of the bee formation. In this study, bee structures were investigated using two microscopy techniques: atomic force microscopy (AFM) and confocal laser scanning microscopy (CLSM). By using model wax compounds, especially blends of waxes differing in melting points and chain lengths, bee structures and surrounding islands were created on featureless bitumen surfaces. Structures very similar to what is observed on a paraffinic bitumen were obtained. This indicates that bees and the surrounding areas both consist of crystallisable components. Moreover, bee structures were also generated on other surfaces, such as mineral oil and a maltene fraction. Bee formation is not limited to bituminous materials and bitumen components are not needed as promotors. Furthermore, CLSM offers possibilities to scan through transparent layers and to investigate surfaces under glass, for example. In contact with such a solid substrate, as well as after water submersion, no microstructural features were observed. Adding a combination of n-alkanes, to transparent oil, induced bee structures at the oil-air interface. The transparency of the oil allowed the visualization of wax crystallization in the bulk, where the added waxes crystallize as small particles. These small crystals are expected to influence the mechanical properties, such as low-temperature stiffening effects, which have been reported for paraffinic bitumen.

Keywords: Bitumen, microstructure, AFM, CLSM

Characterization of hydrophobic-treated recycled paper mill sludge via chemical surface modifications for application as an asphalt modifier

Mohd Rosli Mohd Hasan[1*], Tracy Leh Xin Wong[1], Leo Choe Peng[2], Mohd Fahmi Haikal Mohd Ghazali[1]

[1] School of Civil Engineering, Engineering Campus, Universiti Sains Malaysia,
14300 Nibong Tebal, Penang, Malaysia

[2] School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia,
14300 Nibong Tebal, Penang, Malaysia

[*]Corresponding author email: cerosli@usm.my

ABSTRACT

The asphalt pavement industry has seized the recycling opportunity to transform solid wastes as modifiers into bituminous mixtures while practicing a sustainable approach. This research implements Recycled Paper Mill Sludge (RPMS) as a solid waste additive to partially replace the fine material and mineral filler in asphalt mixture. The raw RPMS required mechanical pre-treatments such as oven-drying, size reduction and sieving. The RPMS that are retained on the 75μm and pan size sieve are adopted for the research. The particles are evaluated by a particle size distribution test to ensure they are well-graded. RPMS is highly hydrophilic; thus, surface modification is required before further application in asphalt mixtures to avoid moisture damage, which will eventually cause pavement distress. RPMS was modified by several methods: esterification using ethanol and methanol, carbonation, a combined method of carbonation and ethanol, and a simple mixing method. The utilization of the ethanol method involves primary transesterification of vegetable oil (e.g., canola oil, waste cooking oil (WCO)) into vegetable oil fatty acid ethyl esters (-FEEs) and followed by a second transesterification reaction by attaching -FEEs to hydroxyl groups chemically on the cellulose nanocrystals (CNC) surface. The methanol surface modification theory is similar to the ethanol method, but it involves vegetable oil fatty acid methyl esters (-FMEs). The carbonation method is carried out in ethanol along with vegetable oils in a wet process. Besides, the combination method is done by combining the most optimum result from the carbonation and ethanol methods, respectively, to achieve a double modification effect. Lastly, the simple mixing method is done by mixing ethanol, RPMS and WCO and then freeze-dried the moist samples. Consequently, the hydrophobicity of various treated fillers is assessed by Hydrophilic Coefficient and Water Contact Angle (WCA). Overall, the ethanol method with 7ml of WCO and the methanol method have achieved the most optimum result in terms of hydrophilic coefficient of 1. The methanol method is not recommended due to its hazardous property. Similarly, RPMS treated by the ethanol method with 7ml of WCO has recorded the highest water contact angle (WCA) among the fillers. As a result, the esterification of ethyl esters utilizing 7ml of waste cooking oil (WCO) and 50ml of ethanol has been adopted due to its most optimum treatment result. The treated particles have smoother surfaces, fewer particles attached, less agglomerated particles, regular particle sizes in spherical shapes than the unmodified particles examined via Scanning Electron Microscopy (SEM).

Keywords: Sustainable pavement, industrial waste, resources preservation, hydrophobicity, morphology.

The properties of recovered binders from various field sites

Hilde Soenen[1*], Xavier Carbonneau[2], Carl Robertus[1], Xiaohu Lu[1], Benoit Tapin[3]

[1] Nynas NV, 2020 Antwerp, Belgium

[2] CST Colas, 78771 Magny les hameaux cedex, France

[3] Nynas AB, SE 149 82, Nynäshamn, Sweden

[*]Corresponding author email: hilde.soenen@nynas.com

ABSTRACT

It is well-known that bitumen aging is contributing to an increased risk for damage on flexible pavements. Binders become harder and more brittle during their lifetime, increasing the risk for cracking and raveling. The general aim of this project is to investigate which binder properties relate to aging-induced damage (block cracking, raveling) in pavements, with a focus to the recently proposed binder parameters, delta Tc (ΔTc) and Glover Rowe (G-R). Other objectives include an evaluation of the aging gradient within the wearing course and the comparison between laboratory and field aging.

Binders were recovered from 12 sites, including locations in Belgium, Croatia, France, UK, with a service life varying between 8 and 21 years. A variety of asphalt surfaces were incorporated, ranging from highways, intercity roads to a racetrack and an airport section. The asphalt mixes consisted of unmodified, and polymer modified binders (PmBs). The asphalt cores, obtained from these sites, were cut horizontally into thin slices, and for each slice the binder was recovered separately. Rheological tests, based on 25-, 8- and 4mm plates were carried out, covering the complete rheological master curve from the glassy up to the flow region. Chemically related properties were investigated by FTIR spectroscopy and by Iatroscan. As the original binders were not available, two approaches were followed to allow a comparison between field and laboratory aging. In a first approach, properties of recovered binders were compared to the behavior of a reference collection of bitumen, collected in the European market over 2012-2014. This set was evaluated extensively before and after short- and long-term aging. In a second approach, the binders recovered from the bottom slice, those which were less aged compared to the top parts, were further aged using the pressure aging vessel (PAV) standard procedure. In this way the bottom slice binder served as a reference binder for the top slices.

The results showed clear tendencies between the data; rheological data could be subdivided into stiffness- and shape-based parameters. Stiffness-based rheological parameters showed a trend with the carbonyl index. When comparing field to laboratory aging the trends were similar, but field aging was in most cases more severe as compared to the standard short- and long-term aging, at least for the rheological properties. For one of the PmBs, differences were observed in the rheological changes at low service temperatures, when comparing the PAV-aged bottom slice to the field-aged top slice. Several aspects of this project will be highlighted in the presentation.

Keywords: aging, delta Tc, Glover-Rowe, recovery, carbonyl.

Session 6A:
Innovaties door green public procurement

CO2 performance ladder: Introduction

Jonathan De Clerck[1*]

[1] CO2Logic

[*]Corresponding author email: jonathan@co2logic.com

ABSTRACT

The CO2 Performance Ladder is an instrument that helps organizations reduce their carbon emissions in the organization and in projects. With a certificate on the Ladder, organizations can receive an award advantage for their registration on tenders. The instrument is used as both a CO2 management system as well as a procurement tool. Organizations that obtain a certificate on the Ladder will experience this as an investment that is immediately returned in terms of low energy costs, material savings and innovations. The ladder's main objective is to stimulate organizations to gain insights in their CO2 emissions, and to continuously seek opportunities to cut back these emissions in the organization and consequently within projects. The CO2 Performance Ladder was originally developed by the Dutch railway concern ProRail in 2009. Since 2011 the system is owned and managed by the Foundation for Climate Friendly Procurement and Business (SKAO).

The CO2 Performance Ladder is a CO2 management system that consists of 5 levels. Up till level 3, an organization that obtains a certificate on the ladder reduces its own carbon emissions within the organization and all its projects. From level 4 and 5, the organization also aims to reduce CO2 emissions from the business chain and sector. An organization that is certified on a certain level (and all previous levels) adheres to the requirements of the CO2 Performance Ladder. These requirements are based on four angles, namely: Insight, Reduction, Transparency and Participation. A minimum score is required for all angles on a specific level.

Each organization certified on the ladder will be subject to annual audits performed by independent and accredited Certifying Institutions (CI). Through these audits, a certified organization ensures the implementation of the CO2 Performance Ladder in its management and projects. Furthermore, the certified organizations will be evaluated annually for their ambitions and initiatives to reduce carbon emissions, and continuous improvement. The Ladder encourages certified organizations to remain ambitious in their efforts to reduce carbon emissions.

Certified organizations receive a fictitious discount on the registration costs of tenders. With a certificate on the Ladder, organizations are rewarded with a concrete award advantage during the tendering process. The higher the level an organization has on the CO2 Performance Ladder, the higher the award advantage. The commissioning party decides the award advantage an organization can receive on each level of the Ladder.

Keywords: carbon emissions, procurement, innovation, climate change, certification.

CO2 prestatieladder: Certificatie

Kim De Jonghe[1*]

[1] COPRO vzw

[*]Corresponding author email: kim.dejonghe@copro.eu

ABSTRACT

De CO_2-Prestatieladder is een CO_2-managementsysteem dat organisaties stimuleert om CO_2 te reduceren op zowel structurele wijze, binnen de organisatie als in projecten en in de toeleveringsketen. Door mee in de gehele keten samen te werken en te innoveren kunnen organisaties hun doelstellingen bereiken. Zoals andere managementsystemen vereist de CO2-Prestatieladder: continue verbetering van inzicht, verdere CO_2-reductiemaatregelen, communicatie en samenwerking in de organisatie. De eisen waaraan een organisatie dient te voldoen staan in "Handboek CO_2-Prestatieladder" dat in eigendom en beheer is van de Stichting Klimaatvriendelijk Aanbesteden en Ondernemen (SKAO).

In Nederland wordt het gebruikt als duurzaamheidsinstrument in aanbestedingen en voor handhaving en heeft het al tot 1,5% extra CO_2-reducties per jaar geleid voor de deelnemende organisaties. Door het succesverhaal van de CO_2-Prestatieladder in Nederland hebben de Vlaamse, Waalse en Brusselse overheden in 2019 besloten om de CO_2-Prestatieladder tot 2022 te testen bij een twintigtal grote overheidsopdrachten in de bouwsector. De organisaties die hun CO_2-uitstoot verminderen zouden in de toekomst een grotere kans maken om overheidsopdrachten binnen te halen.

Een organisatie, die gecertificeerd wil worden volgens een bepaald niveau van de CO_2-Prestatieladder, kiest een door SKAO-erkende certificatie-instelling om het certificatietraject op te starten. Het certificatietraject verloopt zoals alle andere managementsysteemnormen en bestaat uit een vaste cyclus van 3 jaar. Er wordt gestart met een initiële ladderbeoordeling bestaande uit een fase 1 (vooronderzoek) en een fase 2 (toetsingsonderzoek). Na een succesvolle initiële ladderbeoordeling, ontvangt de organisatie een CO_2-bewust certificaat. De gecertificeerde organisaties krijgen hierna een jaarlijkse ladderbeoordeling of een initiële ladderbeoordeling als ze willen stijgen in niveau op de ladder. Aan het einde van de cyclus wordt er een herbeoordeling uitgevoerd en start een nieuwe cyclus van 3 jaar. De certificatie garandeert de efficiënte werking van het CO_2-managementsysteem van de organisatie en zijn projecten door jaarlijkse toetsing van ambitie, reductie en continue verbetering.

Het CO_2-bewust certificaat is 3 jaar geldig en wordt geregistreerd op de website van Stichting Klimaatvriendelijk Aanbesteden en Ondernemen. Het vermeldt het behaalde niveau en de vestigingen waarop het certificaat betrekking heeft.

Keywords: managementsysteem, CO_2-reductie, bouwsector, certificatie.

CO2 performance ladder: Practical case

Franky Van den Berghe[1*]

[1] Willemen Groep

*Corresponding author email: franky.vandenberghe@willemen.be

ABSTRACT

As a leading player in the market, Willemen Infra wants to be an example for other companies to focus on CO_2-reduction in the construction and infrastructure sector. They want to reduce their ecological footprint as much as possible and communicate about this to their stakeholders.

Willemen Infra obtained the CO_2-performance ladder level 3 certificate in January 2021. Thanks to the CO_2-Performance Ladder, they now have a full insight into how much CO_2 they emit within the organization and have set a specific reduction target.

This sustainability policy is translated into practice by using this management system and by developing concrete actions, they ensure that they structurally reduce CO_2-emissions at each of the workplaces.

Willemen Infra is currently working on an upgrade of the CO_2-performance ladder certificate to level 4, which also includes influences outside the organization. This concerns insights into the value chain, scope 3 analysis and specific requirements regarding transparency and participation. As a large company, they therefore will take the structural initiative for development projects, so that new measures for further CO_2-emission reduction in Scope 1, 2 or 3 will be available for application in the sector and to achieve innovations.

During this presentation Willemen Infra want to answer the following questions:

How did they organize this?
How did they do data collection?
How are actions drawn up?
How is an objective determined?
How are the procedures and internal checks drawn up?
How did the external audit go?
Advance to level 4

Keywords: carbon emissions, procurement, innovation, climate change, certification.

Pilootproject GPP Vlaanderen: Opzet en ervaringen

Dirk Van Troyen[1*]

[1] Agentschap Wegen en Verkeer

*Corresponding author email: Dirk.vantroyen@mow.vlaanderen.be

ABSTRACT

The Green Public Procurement pilot project started as an initiative by the Belgian Road Research Centre (BRRC), with the aim to implement the EU GPP criteria into Belgian tenders. In a collaboration between Belgian administrations, the BRRC and road contractors, an Excel tool and a tender text with a number of GPP criteria were devised.

The GPP criteria and tool were implemented in a tender for asphalt renovation on the Flemish road N37 in West Flanders. The project was completed in September 2021.

The selected criteria are divided into an Environmental and a Social pillar. The Environmental pillar consists of 2 main indicators: Global Warming Potential (GWP) and Material Depletion. The Social pillar contains one indicator: Noise production. Each main indicator contains in itself a number of subindicators.

The contractor needs to fill in the expected values for each subindicator in the GPP tool. All the results are weighted and added up to produce a global "Sustainability score". This score, and the price, are the final award criteria.

At the end of the project, the sustainability score is recalculated based on the actual indicator values. Inspections over the course of the project are needed to calculate the actual values. The difference between estimated and actual sustainability score can lead to either a bonus or a fine for the contractor.

In the end it was found that the inspections and calculations were too time consuming to be used for larger scale implementation. Nevertheless, the GPP method had a significant impact on the sustainability efforts of the contractor.

Session 7:
Challenging the performance of asphalt pavements II

Automated vehicles' impact on pavement rutting performance

Ali Yeganeh[1*], Bram Vandoren[1] Ali Pirdavani[1,2]

[1] UHasselt, Faculty of Engineering Technology, Agoralaan, 3590 Diepenbeek, Belgium

[2] UHasselt, The Transportation Research Institute (IMOB), Agoralaan, 3590 Diepenbeek, Belgium

[*]Corresponding author email: ali.yeganeh@uhasselt.be

ABSTRACT

The emergence of automated vehicles (AVs) with the gradual penetration into current roads would allow having different lane distribution scenarios such as using dedicated lanes for AVs (i.e., segregated scenario) or using shared lanes for AVs and human-driven vehicles (HDVs) (i.e., integrated scenario). Besides, AVs' automated steering control system would provide more control over the lateral wandering patterns of the AVs, which could influence the transverse loading time distribution and lane width design, and consequently, cause considerable changes in pavement analysis and design. Accordingly, the AVs' deployment necessitates studying their potential impacts on pavement performance. This paper considers both segregated and integrated scenarios with different penetration rate and lane width scenarios and evaluates the pavement rutting damage induced by the different AVs' wander modes (i.e., zero-, normal-, uniform-time-, and uniform-frequency-wander). This study's finite element simulation results showed that the significance level of the wander mode and lane width effect on pavement rutting damage is highly influenced by the AVs' penetration rate. For instance, the results indicated that the wander mode effect becomes more significant in higher penetration rates than the lower ones. Moreover, when using normal-, uniform-time- or uniform-frequency-wander mode, the lane width effect is more significant in the segregated scenarios with 100% AVs than the integrated scenarios. In contrast, in the zero-wander mode, the lane width effect is more significant in the lower penetration rates.

Keywords: Automated Vehicle, Pavement Rutting Performance, Penetration Rate Effect, Wander Mode Effect, Lane Width Effect

The EU Tyre Label: why does it not reduce the traffic noise in Europe so far and what we can do about this?

Luc Goubert[1*]

[1] Belgian Road Research Centre

[*]Corresponding author email: l.goubert@brrc.be

ABSTRACT

New tyres sold in the EU must be provided with a tyre label since November 2012, mentioning the performance of the tyre with respect to noise emission, wet grip and rolling resistance. Recently (May 2021), two new parameters have been added, namely grip on ice and grip on snow. The idea is to allow the customer to make an informed choice leading to safer and environmentally friendlier road traffic. However, several independent studies have shown that the label reflects reality very poorly. This contribution summarizes the findings of the STEER project, aiming to solve the problems of reproducibility and representativity of the EU tyre (noise) label.

The noise label on a tyre is assigned by means of a pass-by measurement described in UNECE Regulation 117 on a reference pavement which, is described in an ISO standard. This ISO track is a very shallow textured, hence smooth surface. It appears that high-speed roads in Europe are medium or even rough textured, which is logical as a minimum texture is necessary to avoid the risk of aquaplaning. Local roads are in some countries mostly smooth textured but in other countries mainly medium textured. The smooth ISO test track is by far not representative for the common pavement types used on the high-speed roads and neither for a significant fraction of the local roads. For another fraction of the local roads, it is.

Another potentially important reason for the lack of representativity of the tyre noise label is the "family effect": the labelling regulation does not require that all variants of tyres (dimensions, load index, speed index) within a certain family (line) are tested. Therefore, tyre manufacturers only test the noisiest members of the tyre families and assign that result to all the family members, which is perfectly legal, but limits the ability of the customer to choose for the quietest tyres.

Furthermore, to investigate the problems encountered with the reproducibility of the tyre noise label, a comprehensive uncertainty analysis has been made of the measurement procedure as described in Regulation 117, identifying about 40 different sources of uncertainty which could be classified in seven categories. The ISO test track appears to be the main source of uncertainty on the measurement.

Some ideas which will, once implemented, lead to a reproducible and representative tyre noise label will be presented.

Keywords: EU tyre label, noise, uncertainty analysis.

Kan een duurzame en circulaire asfalt toplaag ook nog geluidarm zijn?

Ronald van Loon[1*], Bert Peeters[1]

[1] M+P – raadgevende ingenieurs

[*]Corresponding author email: ronaldvanloon@mp.nl

ABSTRACT

Geluidarme wegdekken worden inmiddels enkele tientallen jaren toegepast. In de zoektocht naar de hoogste geluidreductie worden voor de asfaltmengsels specifieke grondstoffen gebruikt, denk aan de juiste steensoort, steengrootte, gemodificeerde bitumen et cetera. Geluidarme wegdekken hebben de naam dat de technische levensduur korter is dan gebruikelijk en bij het vervangen van een asfaltverharding worden veel grondstoffen en energie verbruikt. Staat het toepassen van geluidarme wegdekken daarmee haaks op de ambitie om minder grondstoffen te gebruiken en CO_2-emissies te reduceren?

Wanneer de noodzaak er is om een geluidarm wegdek toe te passen, wordt de laatste jaren liever gekozen voor een variant met een zo hoog mogelijke levensverwachting. Dat gaat soms gepaard met een minder geluidreducerende werking, maar deze geluidreductie manifesteert zich wel over een langere periode. De grondstoffen voor nieuwe wegdekken worden niet altijd meer 'gewonnen' in de steengroeves uit Duitsland of Noorwegen, maar een steeds hoger percentage van het materiaal wordt hergebruikt in het kader van circulariteit. Dat geldt ook voor de toplagen van geluidarme wegdekken. Het betekent dat de geluidreducerende eigenschappen gerealiseerd moeten worden met herwonnen materiaal. De vraag is dan hoe goed dat gaat: voor een goede geluidreductie luistert bijvoorbeeld de vorm van de stenen en de hoeveelheid fijn materiaal vrij nauw. Kan een circulair wegdek net zo geluidarm zijn als het traditionele asfaltmengsel? Hoe kun je ervoor zorgen dat ook de technische levensduur wordt verlengd en de geluidkwaliteit op peil blijft?

Er zijn mogelijkheden in het laboratorium om vooraf een onderzoek uit te voeren naar de circulaire geluidarme asfaltmengsels. We presenteren welke wegdekeigenschappen hierin belangrijk zijn en gezorgd wordt voor een goede geluidreductie en een acceptabele levensduur. Een andere vraag die hierboven hangt, is welk milieuaspect belangrijker gevonden wordt, een lage CO2-footprint, hergebruik van materiaal of geluidarme wegen? Deze presentatie beschrijft het onderzoek naar nieuwe duurzame asfaltproducten en hun civieltechnische en de akoestische levensloop. Het beantwoordt de vraag of de reductie van geluid, grondstoffenverbruik en CO_2-emissie hand in hand kunnen gaan.

Keywords: geluidreductie, circulair asfalt, levensduur, geluidarm asfalt.

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