East Boundary Road Crumb Rubber Asphalt Trial

Nicholas Lee
Department of Transport

ABSTRACT

The East Boundary Rd Crumb Rubber Asphalt Trial was a recent major trial involving significant collaboration between DoT, ARRB and industry partners with support from AAPA. The trial involved the development and placement of four industry developed crumb rubber asphalt mixes over a 1.4km length on East Boundary Rd, East Bentleigh.

Construction finished in March 2020 and the mixes will be monitored over a two year period. A final report will be published in 2022.

The trial is aimed at increasing sustainable outcomes by further developing crumbed rubber asphalts (CRA) resurfacing mixes in Victoria. This presentation will provide an update on the field performance of the various mixes.

Foamed Asphalt Pavement Recycling Northbourne

Alvaro Amorim[1], Davina Smith[2], David Berg[3]

1. *Transport Canberra (ACT Government),*

ABSTRACT:

Foamed Asphalt Pavement Recycling is the newest innovation in sustainable pavement rehabilitation, introduced to Australia in March 2020. Foamed Asphalt involves insitu foamed bitumen technology with supplementary binder, and a unique paver-laid placement process all undertaken in an efficient single pass, forward moving 'train'.

As part of overall major infrastructure renewal occurring in Canberra and driven by a commitment to sustainable strategies, The ACT Government administered the successful delivery of the first Foamed Asphalt Pavement Recycling project in the Australian Capital City for the rehabilitation of a section of Northbourne Avenue northbound carriageway.

Northbourne Avenue is a major arterial road in Canberra providing critical access from the centre of Canberra, adjacent the recently installed light rail and a link to the Federal Highway. The road pavement showed signs of severe deterioration and was nominated for essential upgrading by the ACT Government. The northbound road pavement of Northbourne Avenue between Macarthur Avenue and Mouat Street was the first stage released to tender. A team of specialist contractors assisted with the delivery of the project, including contributions from Pavement Recyclers, Woden Contractors and Cardno consulting engineers.

The project to upgrade Northbourne Avenue was awarded to head contractor Woden Contractors with a pavement design provided by a consultant. Typical to the current standard pavement rehabilitation methods adopted in the ACT region, a conventional asphalt design was put forth. The original project plan involved removal of the existing pavement and replace with conventional deep lift asphalt, with extensive subgrade replacement – a program scheduled across 26 weeks that would have a tremendous impact on existing daily traffic of 14,000 vehicles per day.

Pavement Recyclers were given an opportunity to provide an alternative pavement recycling solution and consequently deliver the Foamed Asphalt component of the works. With the assistance of Cardno consultants, the final pavement was designed with equivalent design life and performance as the original and conventional construction plan.

Recycling existing materials on site using the Foamed Asphalt process is the most fundamental form of road recycling. The new recycling process makes the most of valuable existing resources, stops waste from going to landfill, and can at least halve greenhouse gas emissions compared with conventional construction.

A Sustainability Assessment undertaken on the project with a comparison between the original project plan and Foamed Asphalt revealed the following estimation of sustainability benefits:

- 6,173 tonnes of existing pavement material was recycled on site
- New imported materials to site was reduced by 69%
- Fast work program of only 6 weeks total including wearing course compared to 26 weeks
- A twenty weeks reduction on traffic impact
- 25% cost savings associated with the overall more efficient process
- A reduction of greenhouse gas emissions (measured in Carbon Dioxide Equivalents) by 61%

In addition to the sustainability and financial achievements, the actual deliverance of the project required extensive collaboration between several entities to ensure all aspects from design stage to construction were thoroughly addressed, due to the high-profile and critical nature of this essential infrastructure project. Such aspects included design, construction logistics and methodology, specifications, additional testing implemented and workplace safety.

The collaboration process occurred over the course of two months prior and during the duration of the project. The challenges that arose with external consultants/superintendent without the knowledge of this process were overcome, and is a demonstration of the key stakeholder's commitment towards the success of the project and overall innovation and progression regarding sustainable infrastructure solutions.

This is an exciting and historical project which involves many facets of significance, however headlines a must-tell sustainability story that epitomises Roads Going Full Circle.

Hybrid binders of tyre derived rubber and SBS meeting conventional PMB specifications

Erik Denneman

Puma Energy, Australia

ABSTRACT

Tyre derived crumb rubber has been used as an elastomeric modifier for bitumen in Australia since the 1950s. Over the past years there has been a resurgence of interest in crumb rubber technology for use in roads, stemming from the need to recycle waste tyres. A number of initiatives are underway in Australia to increase the use of rubber in both sprayed seals and asphalt.

This paper presents the development of a new generation of hybrid binders that contain both crumb rubber and SBS and comply with the existing Austroads polymer modified binder (PMB) specifications. The elastic properties of the rubber and SBS hybrid can be used to create binders that are equivalent to conventional A10E, A15E and A20E grade PMBs. The experimental work described in the paper include binder testing and asphalt performance testing. The paper also describes the implementation from first demonstration sections to full commercial application. The results indicate that the hybrid crumb rubber/SBS binders are equivalent in every way to conventional PMB grades.

Preserving scarce resources by surfacing gravel roads with modified graded seals

Trevor Distin,
COLAS Australia

ABSTRACT

Unsurfaced roads are subject to gravel loss during use and from weather events requiring regular maintenance. Not only are gravel roads expensive to maintain but they consume large volumes of quality granular material to replace that which has been lost due to traffic and erosion. By sealing the unsurfaced road network there is no need to regravel or grader blade them thus preserving the existing gravel and reducing the cost of on ongoing road maintenance.

The presentation will cover the construction of modified graded aggregate seals to surface gravel rural roads in NSW and VIC over the last 2 years. Graded seals were first used in Otta, Norway in the 1960's where alluvial glacial gravel was used in combination with a soft bitumen to surface roads. COLAS have made several improvements to these original Otta seals to provide a longer lasting and more robust surfacing. These improvements include using crumb rubber modified cutback binder and a no fines precoated graded crushed aggregate. These modifications have led to a seal which can tolerate imperfections in the base course preparation more so than conventional single sized seals. If any damage does occur in the seal it has the ability to self-heal under traffic. The newly constructed graded seal is also less prone to aggregate loss from traffic and over time forms a stone skeleton structure to enable it to withstand heavy loaded truck traffic. Case studies will show its use under different conditions including quarry haul roads to demonstrate its versatility.

A study carried out using the typical maintenance costs for rural Council's unsurfaced rural network showed that after 5 years the cost of the modified graded seal would be fully recovered. The use of modified graded seals will help reduce dust pollution, prevent erosion of gravel into our ocean and provide a longer lasting low maintenance surfacing for low trafficked roads over conventional sprayed seals.

Sustainability Assessment for Innovative Pavement Materials, Designs and Processes

Brook Hall
ARRB

ABSTRACT

In collaboration with Main Roads Western Australia (Main Roads) and the Queensland Department of Transport and Main Roads (TMR), the Australian Road Research Board (ARRB) is developing a user-friendly Sustainability Assessment Tool (SAT) to calculate lifecycle greenhouse gas emissions and lifecycle cost benefits of innovative road pavements designs and rehabilitation treatments. A key focus of the new tool is to enable the emissions quantification of pavements using innovative materials (i.e. recycled) designs (e.g. crumb rubber asphalt), and processes (e.g. warm-mixes and in-situ stabilisation).

Once complete, the project will enable Main Roads, TMR and their partners to quantify and compare lifecycle sustainability and economic impacts of innovative pavements consistently and reliably. This will contribute to:

- improved capability in assessing sustainability impacts of designs for new pavements and pavement rehabilitation treatments, including innovative technologies;
- better understanding of the impacts of alternative pavement designs, leading to better long-term investment decision making;
- emissions reductions;
- cost savings;
- reduced landfill, and the promotion of circular economy outcomes; and
- promotion of innovative pavement and recycling industries (incl. job creation).

Assessment results will inform decisions regarding pavement design and material selection, and long-term maintenance strategy over the pavement lifecycle. Furthermore, results will provide data suitable for annual or sustainability reporting and provide key inputs in project assessments, including Infrastructure Sustainability ratings under the ISCA assessment framework.

The tool allows comparative economic and sustainability assessment on a technology-basis or a project basis. Technology-based assessment outputs use a common lane-kilometre basis to show the difference between the base and alternative cases and enable trend comparisons over time and against policy targets. Project-based assessments use real-world project parameters to deliver outputs are expected to help inform pavement design and material selection decisions for request for proposal (RFP) documents, issue for construction (IFC) designs and as-constructed (AC) evaluations.

The SAT will be used to evaluate pavement options in Western Australia or Queensland with a focus on pavement designs or projects that incorporate innovative pavement materials/technologies.

The design of the SAT has strategic linkages with Queensland and Western Australian government and departmental policy objectives and targets including:

- GHG emissions reductions;
- waste reduction and recycling targets;
- supporting innovation and business growth, especially in waste management and pavement construction industries;
- delivering high performing road infrastructure within budget constraints; and
- achieving economic sustainability goals, through reduced lifecycle costs.

The tool's scope, processes and outputs are also aligned with the Infrastructure Sustainability Council of Australia's (ISCA's) Infrastructure Sustainability (IS) rating process and requirements.

Compared with existing methods used in Australia, the SAT is unique as it:

- allows flexibility of various pavement designs, not limited by drop down menus. This allows for the evaluation of new and innovative pavement designs;
- allows for the evaluation of vehicle (use phases) emissions from pavement design and alignment decisions;
- allows for the concurrent economic and sustainability assessment over the pavement lifecycle.

At the time of writing the tool represents a minimum viable product (MVP) built in an Excel platform with linked state-based reference data. The MVP tool is a fully-functional tool that meets the core needs of the clients, but has not yet reached full development maturity, in terms of extended capability, design and a user-friendly interface.

The project next steps include:

- A range of model enhancements, including an additional functionality to optimise outputs and inclusion of additional model outputs (i.e. other air-borne pollutants, Enviropoints, energy & water use).
- A user-friendly SAT using a web-based platform, including a user manual for the model
- report detailing feasibility of opportunities to extend model and its application for broader road infrastructure construction/maintenance use (e.g. culverts, barriers, etc.).

Paving the way towards a more sustainable asphalt

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1. *Colas New South Wales, Newcastle, Australia*

ABSTRACT

Our country still has over half a million kilometres of unpaved roads and over 350,000 kilometres of paved roads which will require ongoing maintenance – that's why its important the pavements sector continues to optimise the materials used in asphalts and refines the production methods utilised to delivery safer and more sustainable solutions to Australia's roads network and wider communities. The recycling of waste materials back into asphalt pavements is not a new concept and can be traced back as early as the 1960's, however, due to such events as India's and China's waste important bans, road contractors now find themselves with intensifying pressure from local, state and federal governments to be a leader in providing a solution to Australia's waste problem. With Australia consuming just under 10 million tonnes of aggregates and bituminous binders every year to produce asphalt, there is a big opportunity to preserve these non-renewable raw materials by substituting them with secondary waste materials. However, there will be challenges that will need to be overcome when transitioning from a linear to a circular economy, such as;

- Incorporating higher proportions of recycled materials while still maintaining equal or greater service life of asphalt products expected by the market
- Optimising materials to ensure we a moving towards a carbon neutral footprint and that the asphalt is recyclable at the end of its service life.
- Modifying our methods of production and placement of sustainable products to ensure we are maintaining safe working conditions for our employee's and minimising harmful impacts to our environments and local communities

The purpose of this presentation will be to perform a study and report on the findings of optimising recycled materials in asphalt and comparing them to the conventional asphalt products. The mixes will be formulated and verify through optimising their laboratory performance using a combination of available recycled products such as RAP, Recycled Crushed Glass and crumb rubber. The optimised blends will be produced in various plants across Australia at lower mixing and paving temperatures to reduce their energy and greenhouse gasses footprint. Liquid adhesion agents will also be used to replace hydrated lime to further reduce the carbon footprint of the asphalt.

The laboratory and plant produced mix results will be reported. Furthermore, to ensure the findings are reliable, it will be the intention to place the mixes on numerous sites and compare their performance to conventional asphalt.

The outcomes of the study will be used to determine confidence levels, benefits learned and ultimately propose as an innovation and alternate methodology towards achieving more sustainable, lower carbon footprint products within the market.

Keywords: sustainability, recycled materials, conventional asphalt, carbon neutral footprint

Towards the Use of Crumb Rubber Modified Asphalt for Local Government Roads

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1. *Brisbane Infrastructure Division, Brisbane City Council*

ABSTRACT

Governments are continually seeking practical measures to address the increasing burden of both domestic and industrial waste streams. End of life tyres are one such waste stream that presents a considerable challenge locally. While crumb rubber modified binders in spray seals have been utilised in Australia since the 1970's, more recent research focus and initiatives to incorporate their use in asphalt have focused on niche applications such as open or gap graded mixtures. Comparatively little research attention has addressed dense graded mixtures for local government roads, and local access roads in particular. Over the past 12 months, Brisbane City Council has begun to examine the potential for adoption of crumb rubber modified pavements for use in such environments where the predominant failure and deterioration mode is primarily due to environmental ageing effects. It is anticipated that the enhanced durability and anti-ageing properties of crumb rubber modified asphalt may provide enhanced pavement life in these applications.

This paper presents Council's initial investigative works towards the use of crumb rubber modified asphalts in their road network. Laboratory works to date have focused on volumetric impacts of a Council Type 2 mixture, a 10mm nominal size light duty dense graded asphalt traditionally incorporating C170 binder. Additional commentary as to Council's research focus for asphalt designs utilising varying crumb rubber proportions is also provided, including proposed simulated ageing methodologies to validate any potential anti-ageing benefits.

World first innovation that effectively addresses the full circle economy repurposing 100% of Australian vehicle tyres to produce and enhance Asphalt properties

David Simmons[1], Gary Foster[2]

1. *Aussee Road Services – Austek Asphalt Production*

ABSTRACT

As all manner of vehicle tyres reach their end of life they often find their way into landfill sites or are subject to illegal dumping. These practices are neither friendly to the environment or sustainable.

With the newly imposed export ban placed on rubber tyres we must find innovative ways to reuse or repurpose this valuable waste stream.

Through collaboration between Pearl Global and Auskek Asphalt Production we have found a symbiotic way to both recycle and reuse end of life local rubber tyres in a world first innovation that greatly reduces greenhouse gases, creates employment opportunity and reduces the import of fossil fuels.

Testing carried out on our asphalt performance has shown that the addition of carbon /char produced from the recycling process enhances the performance characteristics and properties of the asphalt significantly.

When the use of carbon char is coupled with the use of the tyre derived fuel oil also from Pearls disorbtion technology our asphalt plant can minimise to zero the use of diesel or other natural gas resources to fuel the aggregate drying process.

Effectively this paper will present a set of combined processes that showcase a world first innovation where local Australian based companies have created a circular “cradle to grave” opportunity to repurpose 100% of all used vehicle, truck, (Light and heavy duty) to show significant environment and performance benefits.

Use of recycled crushed glass on the Easing Sydney's Congestion Program

Carlos Solis-Navarro[1], Sean Dorahy[2] (to be confirmed)

1. *AECOM*

ABSTRACT

Since 2016, the Easing Sydney's Congestion Program Office (ESC) within Transport for NSW has been implementing various technologies and methodologies that have assisted in delivering an extensive program of urban arterial road upgrade projects in a sustainable and efficient way.

Following this sustainable approach, since 2018, the ESC Program has been liaising with internal subject matter experts and industry to enable the use of recycled crushed glass (RCG) in asphalt. As a result, RCG is now specified as a default replacement of natural sand in asphalt for every ESC project. It is estimated that more than one million glass bottles will be used within ESC projects in the next three years.

The aim of this paper is to describe the key technical considerations and logistics in the use of RCG, and the proposed monitoring framework for this technology. These key considerations include the processing and availability of the RCG, the cleanliness of the constituent material and ongoing monitoring of asphalt mixes across the TfNSW network.

Environmental benefits of Polymer modified Bitumen

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1. *Kraton Polymer B.V., Amsterdam, the Netherlands*

ABSTRACT

Polymer modified Bitumen, PmB, has been used for more than 40 years in the paving industry providing proven technical advantages. It brings high performances with greater rutting resistance and high cracking resistance. Overall better durability and reliability can extend the life time of pavement, delivering long lasting roads. While the technical advantage is well established and documented, the environmental benefits hasn't been yet fully documented. Reliable Polymer modified Bitumen is most often using Styrene Butadiene Styrene block co-polymers, which, by nature, are hydrocarbon based. This, in principle, is contributing in the final environmental impact of the binder, of the asphalt mix using the modified binder, on flexible pavement and finally on the roads going full circle.

In this study, a comparative assessment is made, based on Global Warming Potential, GWP, of an asphalt road surface with and without polymer modified bitumen. The evaluation is based on a typical case study using, as much as possible, reliable data, going from the binder, through the asphalt mix at gate of the plant, to the asphalt pavement surface and over the life time on the road. In addition, sensitivity analysis is included to determine the robustness of the findings towards the various assumptions.

Overall, while SBS can increase the GWP of the binder, its contribution in asphalt mix is only in the magnitude of 10 %. This means on the road, the breakeven point for increased service life is 10 %. When considering a life time of 10 years for conventional bitumen, a road surface using PmB will need to last, at least, 11 years for equal GWP. In reality, this is less than the expected life time extension of PmB asphalt. With a life time average increased by 25 % considered, the GWP will be already lower by 10 % as compared to road surface using conventional bitumen, leading to a more sustainable solution.

Key words: Asphalt mix, Polymer modified Bitumen, Sustainability, Global Warming Potential

Caltrans Gap Graded Technology Transfer with onsite Blended Crumbed Rubber Binder

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2. *Topcoat Asphalt, Adelaide, Australia*

ABSTRACT

The aim of this project was to design, manufacture and pave a Gap Graded Asphalt with onsite blended crumbed rubber binder (GGA/CR) according to the AAPA model specification developed along the lines of the Caltrans specification for this product. The trial would serve as a demonstration project so that GGA/CR could be considered as an alternative equivalent product to the locally used Stone Mastic Asphalt (SMA) by both Local and State Government Authorities. The use of a GGA/CR allows more binder to be incorporated into the asphalt than dense graded asphalt without compromising the performance of the asphalt.

Topcoat Asphalt worked closely with Tyre Stewardship Australia to engage 6 local municipalities in Adelaide to identify local roads for constructing the GGA/CR wearing course. The intention was for this project to generate extensive uptake and exposure to the wider South Australian road consuming sector including input from the SA road authority. A wide range of road base conditions and user circumstances ensured that there would be some challenges encountered during implementation. This would provide a good opportunity to assess the suitability of GGA/CR wearing course over time providing Road Authorities with the confidence to use this tyre derived product into the future.

The mix designs were done at Topcoat asphalt's laboratory using a Superpave gyratory compactor and Hamburg wheel tracking machine to optimise the CR blend and mix properties. The project used an on-site spray seal crumbed rubber blender to modify the bitumen with 20% rubber crumb rather than using a delivered pre-blended product (like S45R). The CR modified binder was pre-treated with a warm mix additive so that the GGA asphalt could be produced at a lower temperature to prevent any fuming.

Pavement Asset Services was requested to review a trial of Crumbed Rubber Asphalt (CRA) including the trial mix and its performance relative to current industry practise. The trial and assessment to occur over two stages. Stage 1 is the profile of the original pavement and its performance to date, then benchmarking the profiled wearing course and reinstating with a side by side assessment of CRA and AC10 Council mix. The existing subsurface and surface conditions were assessed for consistency and will be reported as part of the review. This stage also included a visual assessment of the pavement distress, original pavement profile and collecting of Falling weight deflectometer (FWD) data pre-construction. A final assessment (Stage 2) will be conducted in-service at regular intervals to evaluate relative performance of each mix. This will include reviewing benchmark and in-service performance data including FWD data of the original pavement and the side by side CRA and AC10 mix, Fatigue and Resilient Modulus testing on production and general production and construction practices that can be implemented for future works.

The presentation will present performance data from the Topcoat laboratory (Flexural Fatigue, Resilient Modulus, Hamburg Wheel Tracking and Moisture Sensitivity) for the initial scoping phase and from production samples. The laboratory performance results will be compared against those results obtained when dense graded asphalt using preblended S45R was produced out of the same plant. Field observations and data will also be discussed.

Keywords: Crumbed Rubber, Case Study, Asphalt Performance

Enhancing Sustainability and Durability in Pavement Construction /Maintenance Using a Sustainable Asphalt Reinforcement Geogrid: Practical Experience in Roads and Airfields

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1. *HUESKER Australia*

ABSTRACT

This paper is focused on more sustainable and durable asphalt construction and effective management of pavement deterioration. It will demonstrate that the service life of an asphalt overlay, and of the overall pavement, can be extended considerably by incorporating polyester (PET) asphalt reinforcement technology in both roads and airfield applications.

More specifically, geogrids made from 100% recycled PET are discussed, as a more sustainable way of incorporating recycled materials into roads and pavements in the form of an engineered solution, enabling a truly circular economy together with increased durability.

Through real life project analysis, based on pavement asset data collected over the years, it will present quantified real-world effects of reinforced asphalt overlays on long-term asset performance, maintenance cost reductions, enhanced asset lifecycle, and reduced carbon emissions.

For scientific verification, the paper will focus on laboratory results from Dynamic Fatigue tests comparing reinforced and unreinforced asphalt materials. It will also present the key factors required for an effective asphalt reinforcement geogrid material through Post Construction tests (e.g. residual tensile strength after paving procedures and bond-strength).

Furthermore, following over 45 years' of practical experience with utilisation of polyester asphalt reinforcement geogrid, this paper will include an evaluation of long-term performance in the field in various applications, as well as its limitations in rehabilitation of deteriorated roads and pavements.

The findings presented will conclude that the extended service life of the pavement achieved by the use of this technology reduces both construction disruption to road/airfield operations and the associated maintenance costs to asset owners. In addition, it will conclude that this delivers significant reductions in CO2 emissions not only during construction but also for the service life of the pavement, through reducing the need for non-renewable construction materials.

Making the case for considering marginal materials for foamed bitumen stabilisation

Roberto Espinosa[1], Greg White

1. *Fulton Hogan and University of the Sunshine Coast*

ABSTRACT

One increasing expectation of modern society is the development of more sustainable infrastructure, including roads and other pavement structures. There has been much focus on recycling in roads in recent years, with plastic, waste, glass, toner, concrete and construction rubble all investigated to determine their effects in concrete, asphalt and granular layers. However, the conservation of existing virgin material sources is just as important and one strategy for that is to modify or stabilise marginal materials to produce a fit for purpose product out of an otherwise unacceptable granular material. This research compares foamed bitumen stabilisation of three marginal materials to otherwise identical stabilisation of a standard or reference material. Furthermore, the marginal materials were also pre-improved by blending to correct their marginality prior to stabilisation, and those results were also compared. In all cases, the basis of comparison was cured and saturated resilient modulus values after 3, 7 and 14 days of accelerated laboratory curing. The outcomes demonstrate the potential for some marginal gravels to perform just as well as standard crushed rock after stabilisation, as well as the potential to significantly improve marginal gravels by blending with other marginal materials to pre-correct their deficiency. The recommendations include a more outcome or performance based specification of foamed bitumen stabilisation to allow marginal gravels to be used when they are shown to be fit for purpose.

The Recycled First Policy: Maximising sustainability in Victorian infrastructure

Tony Aloisio
Ecologiq (MTIA), Victoria, Australia

ABSTRACT

Ecologiq is a Victorian Government initiative to optimise the use of recycled and reused materials in transport infrastructure projects, reduce waste and contribute to a Victorian circular economy through Victoria's Big Build.

It is helping to grow domestic recycling capabilities, build local markets, find new uses for recycled materials and bring a uniform approach to the current ad hoc use of recycled materials on transport projects. This involves working with industry partners to identify and remove barriers to the use of recycled content by educating contractors on these products' performance benefits and often significant value for money advantage.

Ecologiq will support the achievement of goals outlined in the **Recycling Victoria** strategy, which defines a holistic plan to reform the state's recycling sector over the next decade. Ecologiq comes at a crucial time for Victoria's waste sector, following China's 2018 decision to restrict the import of local low-quality mixed recyclables and the state's projected generation of 40 per cent more waste by 2046.

Ecologiq is supporting the implementation of the **Recycled First** policy, which requires bidders on transport projects to demonstrate how they will optimise the use of recycled and reused Victorian materials. The policy will help create new local markets for sustainable materials and encourage contractors to maximise the allowable limits of recycled materials and products approved under existing specifications.

Recycled First also includes provisions for contractors to demonstrate innovation through the proposal of project solutions which may be suitable for trial opportunities and lead to the evolution of existing standards and specifications. The policy will fundamentally change the way major transport projects across Victoria are procured and create an intentional, 'business as usual' mindset regarding the use of reused and recycled materials.

While the increased normalisation of the use of recycled and reused materials within existing standards and specifications will contribute greatly to Victoria's vision for a circular economy, there are myriad opportunities to push the boundaries further.

A recent round of innovative trials on the Mordialloc Freeway showed how the widespread use of reused and recycled materials can become the new norm for major transport infrastructure projects.

To date, the project has used more than 100,000 tonnes of recycled crushed concrete in the road base and more than 400,000 tonnes of recycled concrete in under road drainage. Up to 30 per cent of all asphalt laid will be reclaimed asphalt pavement (RAP) and 3.7 kilometres of noise walls will be comprised of 75 per cent post-consumer recycled plastic. That's plastic from disposed bottles and consumer packaging given a second lease of life on Victorian roads.

Another recent trial of crumbed rubber on East Boundary Road in East Bentleigh highlights how government can support the expansion of current standards and specifications and ultimately, the use of increased amounts of recycled materials on transport infrastructure projects.

The trial used four different asphalt mixes incorporating crumbed rubber and two asphalt control sections across a one and a half kilometre section of the south-bound carriageway. The stretch of road will be monitored over the next two years for emissions (compared to

control mixes) and performance, which will allow government and industry bodies to make informed decisions about future updates to current standards and specifications.

The ongoing observation of trial results such as these will help the Victorian Government to assess performance characteristics and inform new specifications that push the boundaries of recycled material use further.

Development of trackless bond coat for providing longer lasting asphalt pavements

Iulian Man[1], Kanjana Yindee[2], Sebastien Chatard[3]

1. *SAMI Bitumen Technologies*

ABSTRACT

SAMIbond 007 is a proprietary polymer modified non-tracking tack coat emulsion specifically developed for airport applications.

The emulsion was designed specifically for airport pavements, with high rutting and fatigue resistance engineered into the material.

The central role of SAMIbond 007 is to improve bond strength between asphalt layers allowing the pavement to act as a monolithic structure under the very high stresses of airport traffic. Due to its good bonding characteristics, SAMIbond 007 is expressly designed to withstand the high shear stresses that develop under aircraft traffic loadings

SAMIBond 007 is designed to allow a higher residual binder application without the risk of sticking to construction vehicle tyres after the emulsion has broken and cured on the pavement. This tracklessness is a critical feature for contractors managing often tight project deadlines.

The presentation will focus on several case studies on SAMIbond 007 usage (Solomon Airport, WA and Sydney Airport)

A kinetic model and practical test method to characterise the composition of crumb rubber derived from end-of-life vehicle tyres

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ABSTRACT

Crumb rubber (CR) has become a common additive to bituminous binders around the world since the 1960s for addressing pavement performance issues as well as tackling the disposal problem of end-of-life tyres (EOLTs). However, EOLT recyclers classify their CR products based on the source of EOL tyre rather than their composition. CR derived from EOL truck tyres is commonly applied in road engineering, while passenger car tyres (PCT) - holding large portion of all the EOL tyres volume - are seldom re-processed into CR products. The usage of CR from passenger car tyres is narrowed and doubted, even though the rubber composition in most tyres is identical with some difference in the percentages of contents which are natural rubber, synthetic rubber, carbon black, oil and fillers.

It is thus necessary to introduce a justified test method to characterise CR composition and further classify CR products based on their chemical composition. This can lead to CR specifications based on the percent of natural rubber, for instance, rather than on the source of the EOLTs (i.e., truck, passenger, 4x4). A kinetic model was built based on the outcomes of the pyrolysis decomposition of CR by using Thermogravimetric analysis (TGA) and Fourier Transform Infrared (FTIR). The potential of combining them as Evolved Gas Analysis (EGA) was also researched. The model can estimate the percentage of the main components in CR, which can then be used as the corner stone of standardised test methods to build a smart EOLT recycling system for road applications.

Using a Crumbed Rubber Modified Asphalt Surface Inlay and Ultra-Thin Friction Course to Restore the Integrity of a Previously Rehabilitated Alkali-Silica Affected Plain Jointed Concrete Pavement (PJCP)

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1. *Royal HaskoningDHV (RHDHV), Cape Town, South Africa*

ABSTRACT

The National Route 2 Section 1 dual carriageway between the Cape Town International Airport and Somerset-West in South Africa was designed and built between 1970 and 1971 as a Plain Jointed Concrete Pavement (PJCP) with a flexible pavement structure for the shoulders and interchange ramps.

During 1975, severe surface cracking was observed along the contraction joints. Alkali-Silica Reaction (ASR) was constituted, which resulted in excessive expansion within the concrete slab as a result of chemical reactions between the alkalis in the cement and silica mineral constituents in the Malmesbury Group Hornfel aggregates. It was obvious at the time that rehabilitation of the jointed concrete pavement had to be carried out. Options of re-construction, overlaying and continuous maintenance were initially considered.

In order to reduce or even to prevent a continuation of the ASR deterioration, it was decided to seal off the concrete surface from environmental conditions, mainly preventing exposure to moisture and to allow the concrete to dry out. This was achieved by sealing off the concrete with a 14 mm stress absorbing membrane interlayer, followed by the construction of a 40 mm crumbed rubber modified semi open graded asphalt overlay in 1986 to preserve the integrity of the dual carriageway jointed concrete pavement.

The expected life of the rehabilitation action was initially eight years before significant reflection cracking would start to occur. Serious maintenance or even rehabilitation was only anticipated after twelve years of traffic loading. The above measures could therefore, be regarded as successful, as since 1986, no major periodic maintenance measures had to be conducted to uphold the integrity of the of the road surface.

The condition of the road surface in 2017 after 30 years of traffic loading deteriorated significantly. The asphalt surface exhibited reflective cracking of the concrete contraction joints. Additional cracking started to branch off the reflective cracks and at numerous contraction joints it was observed that shoving of the asphalt was taking place in the wheel tracks, confirming the partial delamination of the asphalt surface from the jointed concrete pavement.

This paper describes the initial investigations, alternative and preferred solutions, detailed design development and construction of the crumbed rubber modified asphalt surface inlay and ultra-thin friction course, identified as the most cost effective remedial action to restore the integrity of the previously rehabilitated, alkali-silica affected Plain Jointed Concrete Pavement (PJCP).

Innovations in pavement engineering: high performance hybrid-modified bitumen for roads and airports

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ABSTRACT

Polymer-modified bitumen (PMB) has been in use for decades in Australia; however, the majority of PMB currently sold for road and airport applications still includes the same polymer type (e.g., SBS and EVA) and content that was indicated by the standards in the 1990s. To date, polymers science has made incredible progress and today's polymers can provide enhanced performance and compatibility with bitumen if wisely combined in hybrid forms. This study elaborates on the joint effort between a bitumen supplier and a university to develop an ultra high-performance binder based on the combination of four polymeric pillars to form a hybrid-modified bitumen. The combination of polymers was specifically selected for targeting the harsh Australian conditions with superior resistance to rutting even at very high temperature and enhanced fatigue resistance (i.e., comparable to SBS-modified bitumen). Analyses in the laboratory highlighted the binder advantages over currently available PMBs. Thanks to its superior properties, the hybrid binder has been applied in field projects and trials. This study will also include the presentation of recent field installations showing the various steps of the projects, from the mix-design to workability and performance in the field.

Encapsulated biochar used as bitumen replacement and/or additive

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ABSTRACT

The purpose of this paper is to present the properties of asphalt with binders containing various percentages of plastic encapsulated biochar. The conventional properties of the modified binder were evaluated in terms of their rheological and physical properties. Modified bitumen samples were produced by mixing base bitumen with plastic encapsulated biochar and asphalt mix was made by dry and wet procedure. Due to its carbon nature and morphology the plastic encapsulated biochar has a twofold impact on the properties of bitumen, namely: it acts as an antioxidant thus retarding the ageing properties of bitumen and secondly it stiffens the bitumen by increasing its rheological (flow) properties. The trial results will be compared to lab results.