THE UNIVERSITY OF TEXAS AT AUSTIN ✦ COCKRELL SCHOOL OF ENGINEERING
TEXAS PAVEMENT PRESERVATION CENTER
TxDOT
Newsletter
ISSUE 31 / SUMMER 2013

Summer 2013 / Issue 31

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TRB 92nd Annual Meeting

Our Mission

The mission of the TPPC, in joint collaboration with the Center for Transportation Research (CTR) of the University of Texas at Austin and the Texas Transportation Institute (TTI) of Texas A&M University, is to promote the use of pavement preservation strategies to provide the highest level of service to the traveling public at the lowest cost. The executive sponsor for the TPPC is the Texas Department of Transportation (TxDOT).

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92nd Annual TRB

The Transportation Research Board (TRB) 92nd Annual Meeting was held in Washington, D.C. at the Washington Marriott and Hilton hotels. The information-packed program attracted nearly 12,000 transportation professionals from around the world to Washington, D.C., January 13-17, 2013.

The TRB Annual Meeting program covered all transportation modes with more than 4,000 presentations in nearly 750 sessions and workshops addressing topics of interest to all attendees—policy makers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions. More than 40 sessions and workshops addressed the spotlight theme for 2013: Deploying Transportation Research - Doing Things Smarter, Better, Faster.

The following pages will provide brief summaries of fourteen presentations that were of interest to the TPPC due to their focus on pavement preservation and rehabilitation.

Laboratory Evaluation and Field Investigation of Asphalt Pavement Crack Seal Band

by Feng Li, Xiaopei Shi, Wei Zeng and Jian Xu

Seal Band Test Specimen

Li et al. state that the traditional crack seal materials, such as bituminous or silicone sealants, fail to be traffic-ready quickly enough – a requirement for roads with high-volume traffic. As a result, a new sealant material called a seal band has recently been introduced for crack filling. Three test methods were proposed to evaluate the seal band: penetration cone, softening point and modified bond. Using these tests, the seal band's installation configuration and field performance were investigated. Field studies indicate that the treatment's installation did not require melters, pumps or routing cracks. The application process was as simple as blowing the pavement to ensure that the surface was clean and dry, then unrolling and applying the material to the surface. This study showed that the seal band could fail in three ways: cohesion failure, adhesion failure and pullout. The study also discovered that the seal band exhibited better field performance than silicone and hot-applied sealants. Once installed properly, the seal band also prevented water intrusion and the pavement's deterioration.

Example of Cohesion Failure

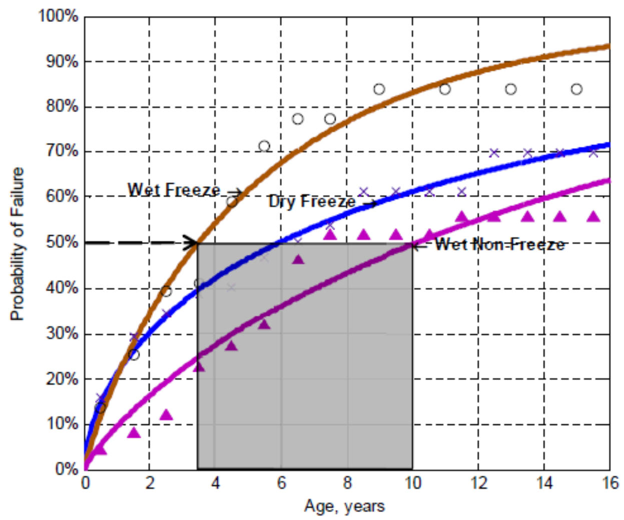
Laboratory evaluation and field investigation resulted in the following conclusions:

- The seal band exhibits good high-temperature performance but was less effective at low temperatures.
- Installation of the seal band is a simple operation requiring little personnel and training. Additionally, traffic can be reopened immediately after installation.
- In the Xinjiang province of China, seal bands exhibited good in-situ performance in comparison to silicone sealant and hot-applied sealants, both in crack sealing and crack filling configurations.
- While easy to apply, multiple types of failure was observed in testing the seal bands.

Survival Analysis of Thin Overlay and Chip Seal Treatments Using the Long-Term Pavement Performance Data

by Litao Liu, and Nasir G. Gharaibeh

Liu and Gharaibeh argue the importance of preservation treatments in retarding a pavement system's deterioration and in maintaining and improving its functional condition without substantially increasing its structural capacity. Their study provides an empirical assessment of the longevity of two commonly-used preservation treatments for hot-mix asphalt (HMA) pavements: thin overlays (0.5-2 inches in thickness) and chip seals. The data was extracted from the Long-Term Pavement Performance (LTPP) database and covers forty states and eight Canadian provinces. In order to estimate the treatments' life expectancies and probability for failure, failure curves (survival curves) and mathematical models were developed. In order to account for the climate's effect on treatment performance, separate failure curves were developed for four climatic zones: dry freeze, dry non-freeze, wet freeze and wet non-freeze. The study analyzed 341 thin overlays and 192 chip seals from the LTPP database. The models developed in this study can be a great assistance in determining the likely condition of a thin overlay or chip seal in a given climatic region. In order to do so, one must simply indentify the age of a specific treatment and whether it has been applied in a dry-freeze, wet-freeze, dry non-freeze, or wet non-freeze zone. Plugging these two variables into this study's model will reveal the treatment's expected probability for failure – as seen in the graph below for chip seals.



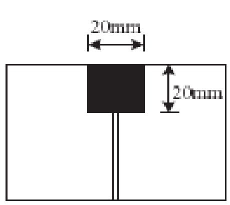
Chip Seal Age-Failure Graph in Different Climactic Conditions

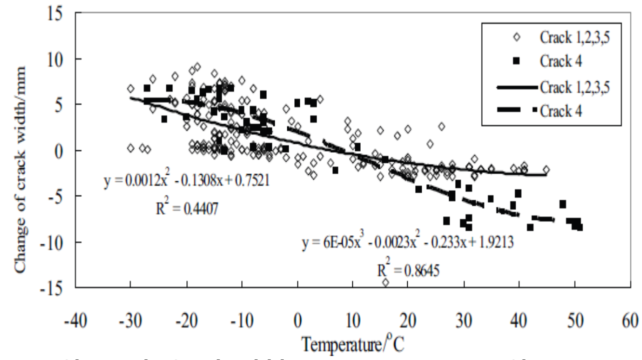
The median life expectancy for thin overlays was 7–9.5 years, and for chip seals it was 3.5–10 years, depending on the climatic zone. In terms of traffic loading, the median life expectancy for thin overlays was 1,500–8,000 cumulative KESALs, and for chip seals it was 500–2,000 cumulative KESALs, depending on the climatic zone [1 KESAL = 1,000 equivalent single-axle load (ESAL)]. The wide range in life expectancy among the four climatic zones signifies the climate's effect on treatment performance.

A Preliminary Analysis on Determination of Optimum Crack Sealing Time for Asphalt Pavement

by Junyan Yi, Decheng Feng, Shih-Hsien Yang, and Fei Yu

Yi et al. state that cracking is a major cause of failure in asphalt pavements and that it increases the severity of other distresses. Crack sealing is an effective method for preventing such failures; however, there has been no standard procedure to determine the optimal sealing time for cracks. This study sought to establish a preliminary crack opening model for the northeastern region of China. Generally, the absolute change value for crack width in one year is much higher than it is in one day. Therefore, this model was established based on the year-round observation data for unsealed asphalt pavement. The 20×20 mm square reservoir for crack sealing was selected in order to determine the sealing time's effect on the crack seal's performance. The median life expectancy for thin overlays was 7–9.5 years, and for chip seals it was 3.5–10 years, depending on the climatic zone. In terms of traffic loading, the median life expectancy for thin overlays was 1,500–8,000 cumulative KESALs, and for chip seals it was 500–2,000 cumulative KESALs, depending on the climatic zone [1 KESAL = 1,000 equivalent single-axle load (ESAL)]. The wide range in life expectancy among the four climatic zones signifies the climate's effect on treatment performance.





Change in Crack Width Due to Temperature Change

The median life expectancy for thin overlays was 7–9.5 years, and for chip seals it was 3.5–10 years, depending on the climatic zone. In terms of traffic loading, the median life expectancy for thin overlays was 1,500–8,000 cumulative KESALs, and for chip seals it was 500–2,000 cumulative KESALs, depending on the climatic zone [1 KESAL = 1,000 equivalent single-axle load (ESAL)]. The wide range in life expectancy among the four climatic zones signifies the climate's effect on treatment performance.

Effectiveness of Heavier Tack Coat on Field Performance of Open-Graded Friction Course

by Nam Tran, David Timm, Gregory Sholar, Buzz Powell, and Richard Willis

Tran et al. state that one way to protect an open-graded friction course (OGFC) from distresses, such as cracking and raveling, is to enhance the interface bond between the OGFC and the underlying layer by applying a heavier tack coat. This study evaluated the effectiveness of this method by comparing the field performance of the OGFC mixture, which was placed in Sections N1 and N2 on the NCAT Pavement Test Track.

In Section N1, a heavier polymer-modified tack coat was applied using a spray paver just before placing the OGFC layer. In Section N2, a trackless tack was applied at a normal application rate using a distributor truck. The sections were trafficked for two years at the equivalent of 10 million single-axle loads by a fleet of heavy trucks. The field performance of these sections was monitored on a weekly basis by measuring pavement stiffness, pavement structural response, surface functional characteristics and pavement distresses.

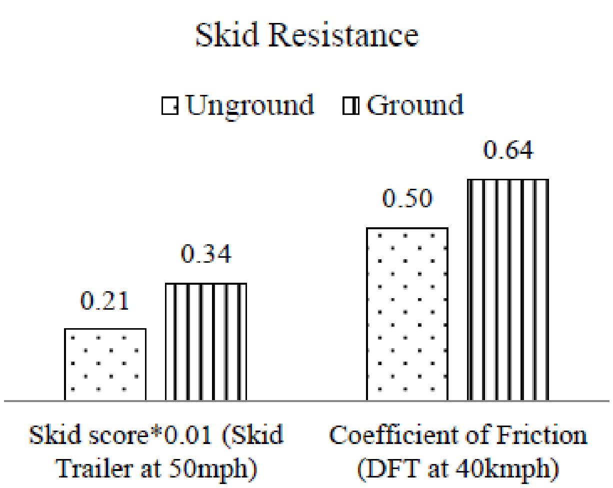
Tack Rate Comparison After Heavy Rain

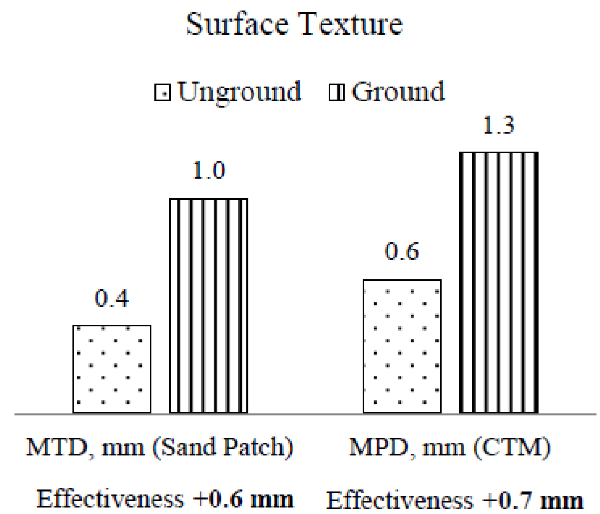
The results of this study showed that the OGFC layer in Section N1, onto which a heavier tack coat was applied, performed better than that of Section N2, onto which a conventional tack coat was applied. What's more, the back-calculated AC modulus and pavement response data were stable over time for the N1 section which inicates that the pavement structure for the section with heavier tack was in reasonably good health throughout the testing cycle. By the end of the testing cycle, the N1 section exhibited about half the rutting in comparison to the N2 section. Cracks were also more severe in the N2 section. Finally, the N2 section ever showed better drainage than the N1 section during periods of heavy rain. Therefore, it recommended using a heavier tack coat for improving the OGFC's performance.

Evaluation of the Benefits of Diamond Grinding of a CRCP

by Prasad Buddhavarapu, Andre de Fortier Smit, Ambarish Banerjee, Manuel Trevino, Jorge A. Prozzi

Buddhavarapu et al. state the benefits of diamond grinding on a continuously reinforced concrete pavement (CRCP), a technique that is used for improving pavement functionality in terms of surface macrotexture, skid resistance, roughness and noise. Its effectiveness at improving these properties was calculated based on in-field observations. The effects of three pre-existing conditions – carpet drag, burlap drag and transverse tining – on diamond grinding's effectiveness was also evaluated. The results showed that diamond grinding improved the surface macro-texture by 0.6 mm and skid resistance by approximately 60%. The surface roughness of the diamond ground sections were reduced, on average, from 124 to 80 inch/mile. An average reduction in noise level of 3.2 dB also was observed. A maximum reduction of 5.6 dB at 1,600 Hz was observed in the region of noise frequencies (1,000-2,500 Hz). The grinding procedure produced a relatively uniform surface in terms of these properties, despite the pre-existing conditions in the CRCP.



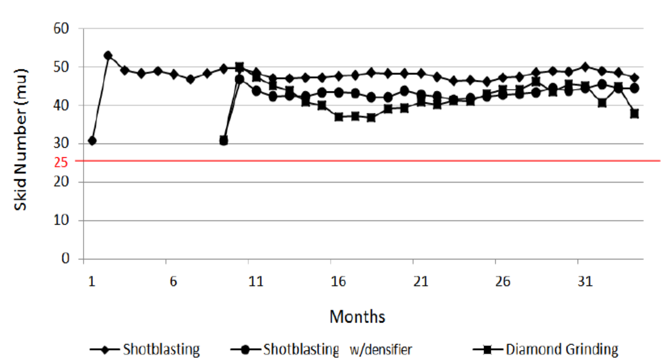


This study provides sufficient statistical evidence for the claim that grinding operations produce a relatively uniform surface in terms of macrotexture, skid, roughness and noise levels regardless of the variation in pre-existing conditions of CRC pavements. Despite this conclusion, monitoring the rate of deterioration of such pavements is recommended for assessing the overall efficiency and cost-effectiveness of surface grinding operations.

A Comparative Analysis of Life Cycle Cost Analysis Methods of Asphalt and Concrete Pavement Preservation Treatments in Oklahoma

by Dominique Pittenger, Douglas D. Gransberg, Caleb Riemer, and Musharraf Zaman

Pittenger et al. state the benefits of using life cycle cost analysis with engineering data when selecting asphalt and concrete pavement preservation treatments. The project built on research done in Australia and New Zealand by conducting a long-term study of 23 methods for restoring pavement skid resistance by retexturing the existing surface with either a surface treatment, a chemical treatment or a mechanical process. This study demonstrated the methodology using field trial data for selected treatments. It also provided a comparative analysis of various methods for coupling technical engineering data with economic analysis through the use of deterministic, stochastic and performance-based life cycle cost analysis.



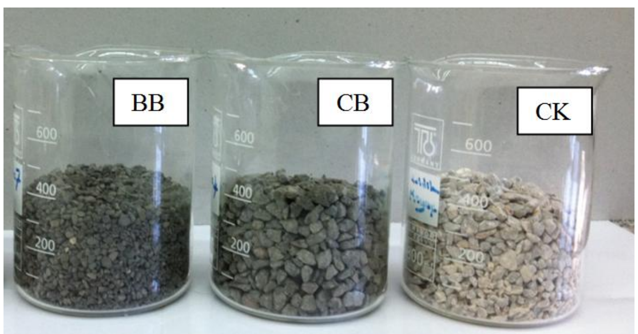
Comparison of Friction Treatments on Concrete Pavements

The study concluded that, although the combination of skid resistance, macrotexture and financial data is sensitive to the analysis method, the methodology provides a powerful tool for selecting the appropriate treatment for a given road.

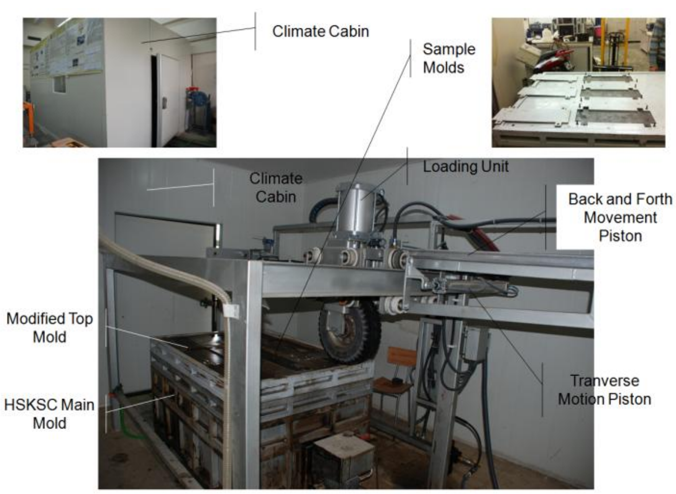
Experimental Investigation of Chip Seal Adhesion Performance with Modified Binder in Cold Climate

by Bekir Aktas, and Mustafa Karasahin

Aktas and Karasahin evaluate chip seal performance with both neat bitumen and polymer-modified bitumen chip seals, each of which was constructed with different aggregate combinations that emphasize aggregate retention using an Accelerated Chip Seal Simulation Device (HSKSC). The aggregate retention performances of each chip seal were compared with three types of aggregates at low temperatures.

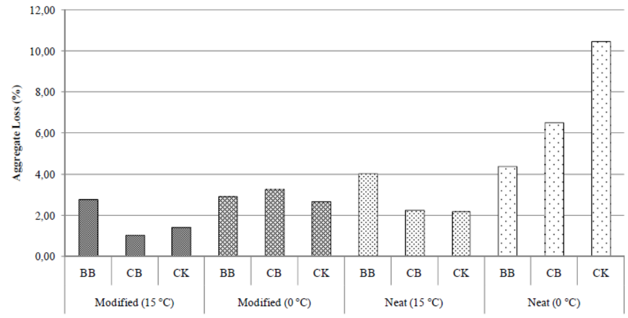


Aggregate Used in Experiments



HSKSC and Climate Cabin

This research found that polymer modification of neat bitumen improved aggregate retention performance in all climatic conditions. The results also showed that a decrease in temperature caused an increase in aggregate loss, so a modified binder is even more crucial in cold climates.



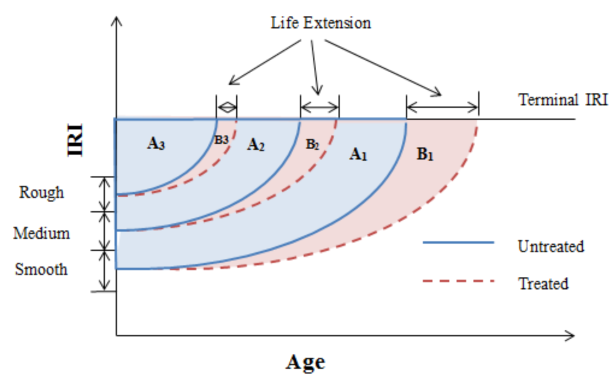
Comparing Final Aggregate Loss

These test also confirmed that most of the aggregate loss occurs during the initial wheel loading. Because of this, close attention must be paid to traffic control precautions immediately following chip seal construction

Relative Benefit of Chip Seal in Different Climatic Conditions Based on Initial Pavement Roughness

by Matild Dosa, and Michael S. Mamlouk

Dosa and Mamlouk state that preservation methods should be applied before pavements display significant environmental distresses. Optimal timing in applying pavement preservation treatments will extend the roadway's service life for the longest possible period with the lowest possible cost. This study examined the long-term effects of chip seal treatment in four climatic zones in the US. The Long-Term Pavement Performance (LTPP) database was the source of roughness and traffic data and the maintenance and rehabilitation histories of both treated and untreated sections. The sections were categorized into smooth, medium and rough pavements, based on its initial condition as determined by the International Roughness Index (IRI). Pavement performance of treated and untreated sections was modeled using exponential regression analysis. Preservation effectiveness was evaluated in terms of life extension, relative benefit and benefit-cost ratio.



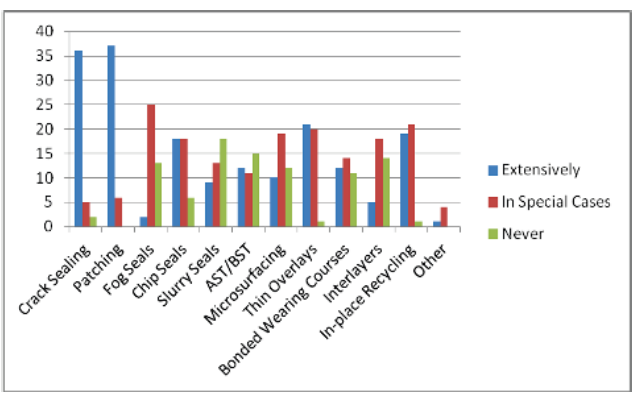
Relative Benefit and Life Extension with Respect to Treatment Timing and Initial Condition

The results verified the assumption that treated sections performed better than untreated sections. Life extension, relative benefit and benefit-cost ratio were highest for the sections that were smooth at the time of treatment; conversely, these measures were lowest for the sections that were rough at the time of treatment. The effectiveness of chip seals showed no correlation to climatic conditions or traffic levels. That is, the relative benefit of chip seal treatments was dependent on the initial condition of the pavement and not on the present climate or traffic conditions. The study recommends that other treatments be examined in a similar way as shown in the study. Doing so would provide insight into whether certain treatments have different success rates than observed in chip seals in rehabilitating deteriorated pavements. Finally, the study also suggests that the same type of analysis be performed on pavements that have received multiple applications of chip seal treatments. Doing so would show whether the benefit of a chip seal can be maximized by applying the treatment multiple times in a row.

Development of an Enhanced Alaska Pavement Preservation Program and Strategy Selection Guide

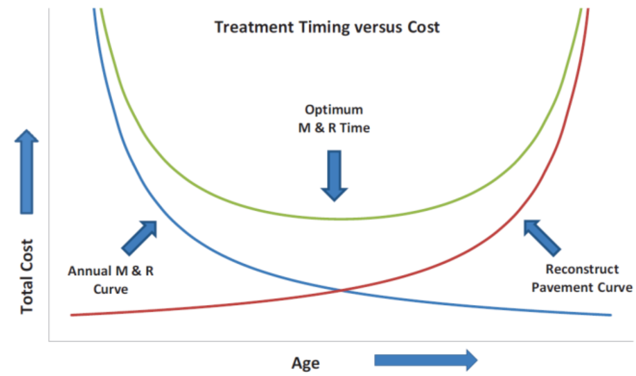
by DingXin Cheng, R. Gary Hicks, Angela Parsons, Hannele Zubeck, Jenny Liu, and Anthony Mullins

Cheng et al. state that the Alaska Department of Transportation and Public Facilities (Alaska DOT&PF) recently has completed a pavement preservation study to improve its preservation program for flexible pavements. The research tasks include: (1) conducting an international survey on pavement preservation in cold regions; (2) reviewing literature on pavement preservation in cold regions; (3) monitoring current treatments used by Alaska DOT&PF; (4) creating a pavement preservation database; and (5) developing a computer program for online treatment selection. The database is an online program that includes: the standard pavement preservation strategies that are used in Alaska; pavement construction, traffic, weather and other performance-related information; an integrated Google Map that displays the locations of pavement preservation projects; and several pavement condition surveys with their supporting documents.



Survey Results: Extent of Treatments Used

The strategy selection program has been integrated into the pavement preservation database. It utilizes the results of the survey and other information on Alaska treatments in order to select a treatment strategy and determine a life cycle cost analysis. The tools developed for Alaska DOT&PF are useful for the long-term implementation of effective pavement preservation programs as other agencies can learn from Alaska's experience.



Treatment Timing versus Cost for Optimum Maintenance & Rehabilitation

Two flexible pavement strategy selection matrices were developed to select the feasible treatments based on the pavement distresses, traffic loading, weather and climate region, etc. The treatment selection program utilizes the life cycle cost analysis to rank the feasible treatments. The treatment selection program is easy to use and report. It has only five simple steps. However, it is very important to ensure the accuracy of the input data such as distresses, cost, expected life, and interest rates. The quality of the analysis is only as good as the quality of the input data.

Effect of Emulsion Content and Cement Loading on Cold Recycling Mixture Fracture Energy Measured Using the Semi Circular Bending Fracture Test

by Stephane Charmot, Andrew Braham, and Kefei Zhang

Charmot et al. state that cold recycling is an attractive alternative to rehabilitating asphalt concrete pavement, especially in terms of cost-effectiveness and sustainability. Cracking resistance is a critical property that often is not considered in the design or acceptance of cold recycling mixtures. The Semi Circular Bending (SCB) fracture test with the testing parameters defined in this study provides a practical method for evaluating the cracking behavior of cold recycling mixtures. An experimental design evaluates the effects of emulsion content and cement loading on SCB fracture energy. The results indicate that asphalt emulsion content and cement loading, and their interaction, are significant with the fracture performance testing of cold recycling mixtures.

CIR Process

This study determined that the SCB fracture test is useful for quantifying the cracking of cold recycling mixtures in the laboratory. Also, higher cement loading could be detrimental from a cracking standpoint, particularly at lower emulsion contents. Cold recycling mixtures properly designed with satisfactory materials should yield fracture energies in excess of 500 J/m^2 (when tested at 10^{o}C).

Development of Fog Seal Field Test Methods and Performance Evaluation Using Polymer-modified Emulsions

by Jeong Hyuk Im, and Y. Richard Kim

Im and Kim state that chip sealing is among the most cost-effective pavement preservation treatments used in North Carolina; however, the primary concern with it is aggregate loss. Fog seals are useful for preventing or reducing aggregate loss in chip seals and for extending the pavement's service life. This study compared polymer-modified emulsions (PMEs) to unmodified emulsions as fog seal materials. It showed that polymer modification can improve certain properties of emulsions, such as adhesion. The evaporation test and the pneumatic adhesion tension testing instrument (PATTI) test were used to investigate the emulsion's curing and adhesive behavior. Also, the rolling ball test and the damping test were developed as in situ methods for determining the appropriate time for opening roadways treated with fog seals. Finally, the third-scale model mobile load simulator (MMLS3) was used to compare the 16 performance properties of the fog seal emulsions.

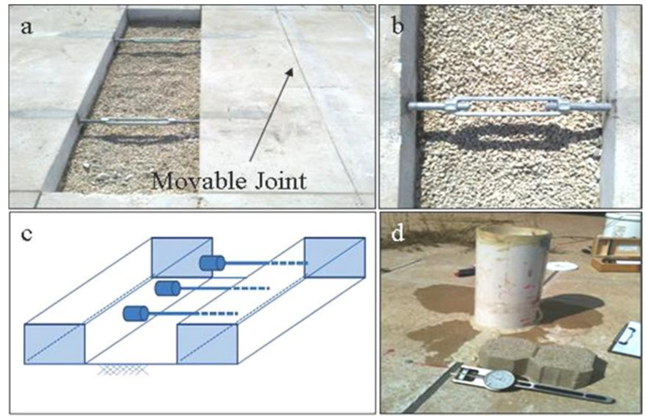
This study found that:

- PMEs improve emulsion bond strength and shorten the time that a road is closed to traffic
- PMEs exhibit more effective emulsion curing rates than unmodified emulsions
- A strong relationships exist among the bond strength and both the rolling distance and the percentage of stained area, which are measured from the rolling ball test and damping test
- the field test methods are useful for determining whether the emulsions are fully cured
- PMEs exhibit better aggregate retention and bleeding performance than unmodified emulsions

Evaluation of Joint Sealant Effectiveness on Moisture Infiltration and Erosion Potential in Concrete Pavements

by Keivan Neshvadian, Dan G. Zollinger, and Youn su Jung

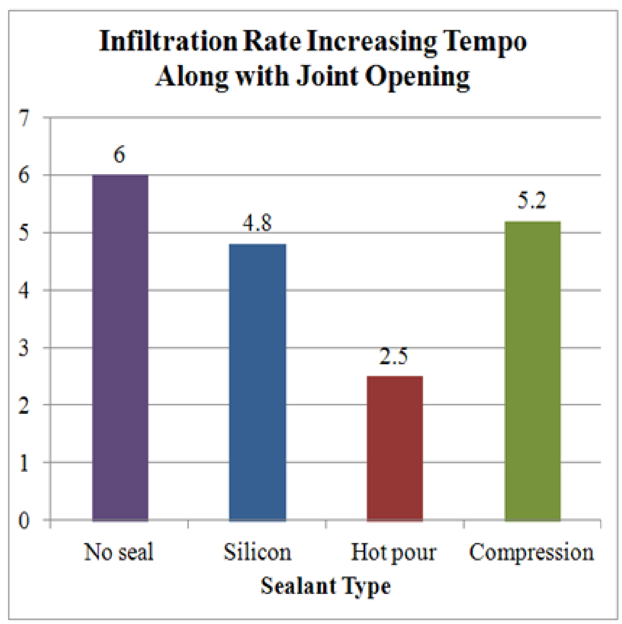
Neshvadian et al. state that an experimental program was conducted on the Riverside Campus of Texas A&M University in order to study the effectiveness of different sealant types at limiting drainage-related joint infiltration through different joint openings. The experiments included three sealant types: silicon, hot-pour and preformed sealants, each with different joint reservoir geometry and de-bonding conditions. A movable joint system was employed to simulate joint widening.



a) The movable joint system in the field b) The turn buckle used to move the slabs c) The schematic view of the movable joint system d) Flow test in the field

This study concluded that:

- It is important to have sealants in jointed concrete pavements
- The unsealed joints have significantly higher flow rates than damaged sealants
- The preformed sealants performed best
- Sealants installed on dirty joint well walls do not bond well and thus perform poorly. The effects of joint seal installation and the drainage quality of the pavement system was directly employed within a faulting prediction model as a reflection of base erodibility. Included in the model were the three main elements of erosion: the rate of base/subbase erosion (as quantified in laboratory conditions); the existence of moisture under the slab; and traffic. The model represented the effects of joint seals on concrete pavement performance.



related This study emphasizes that the presence of water on the interface coupled with the effect of traffic and erodibility are the three main elements of the erosion process. The study states that the most valuable outcome of the research is the demonstration of the role of joint sealing on the service life of jointed concrete pavements.

By limiting water infiltration into the joint, sealants can improve concrete pavement performance.

Laboratory and Field Evaluation of Cold In-Place RAP Recycling

by Amanda Helena Marcandali da Silva, Kamilla L. Vasconcelos, Ana Luisa Aranha, Liedi Légi Bariani Bernucci, and José Mario Chaves

Marcandali da Silva et al. state that cold in-place recycling (CIR) is a viable pavement rehabilitation technique, which recycles 100% of reclaimed asphalt pavement (RAP) in situ and without heat. Six test sections were constructed on a high-traffic road in southern Brazil using CIR with cement and cationic slow-set polymer-modified emulsions (CSS-1P). Recycled layers of varying thicknesses (80, 110 and 150 mm) and two kinds of asphalt surface layers (HMA and Microsurfacing) were investigated.

The RAP was sampled during the recycling operations and brought to the laboratory for a mechanical evaluation (tensile strength, moisture sensitivity and triaxial resilient modulus). Field samples were obtained from the test sections in order to evaluate the recycled mixture's performance. They were tested for indirect tensile resilient modulus and rutting resistance (LCPC wheel tracking test). The structural evaluation of the test sections was performed through the FWD in different seasons of the year.

A decrease in the modulus of the recycled layers during the rainy season was observed. The tests also indicated a moderate sensitivity to moisture. The back-calculated resilient moduli of the CIR layer presented the same order of magnitude as the moduli in the laboratory tests. After two years of rehabilitation, the CIR exhibited reduced permanent deformation in the laboratory and low rutting in the field.

Use of a Variable Rate Spreader Bar (VRSB) To Minimize Wheel Path Bleeding for Asphalt-Rubber Chip Seal Applications

by John La Bar, J. Shawn Rizzutto, and Petrina T. Johannes

Bar et al. state that in order to avoid distresses in chip seals, such as raveling and bleeding, it is critical to select the proper application rates for binders and aggregates. It is also necessary to implement a clear plan for quality control with effective verification of the application rates.

It is commonly observed that most bleeding and flushing occurs in the wheel path due to the inherent differences in traffic loading in and out of it. This has prompted the need for varying the application rates between the wheel and non-wheel path areas.

This study includes a review of several field studies in which both uniform and variable application rates were used to construct Asphalt Rubber Binder chip seals in California. Observation of early (soon after construction) and late (up to 6 years after construction) performances showed the importance of using a Variable Rate Spreader Bar (VRSB) in mitigating the wheel path's premature bleeding.

Variable Rate Spreader Bar

The study included the development of a field calibration test method, a modification of the CTM 339-2000. However, distributor spreader bars are not always accurate to the required tolerances, therefore calibrations are essential for successful placement of all binder applications (including the variable rate spreader practice). Due to distributor bar variances in manufacturing and design, hydraulic pressure is not constant at each nozzle, therefore individual nozzle size adjustments must be made to produce a uniform application rate. Additionally, due to nozzle production tolerances and nozzle wear, actual opening measurements need to be verified, so the hydraulic pressure does not fluctuate. Since the wheel path is subject to higher traffic, it is recommended to reduce the application rate in the dense wheel path area to mitigate flushing, and increase the binder application rate in the non-wheel path area to prevent raveling. Various size spray nozzles should be considered to equalize hydraulic pressure, which will produce uniform application rates across the distributor spreader bar. Also using steel nozzles, with a higher heat tolerance, in lieu of the normal brass nozzles should decrease the possible warping of the nozzles due to high temperatures.