Research Need Statement 597

Date 5/3/19

Need Statement Champion

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Idea Submitted by: LRRB via Priority Process (3/19/19 Mtg)

Idea Originated from: 2019 LRRB Idea Solicitation Process (Pre-Screen Board mtgs)

Select Program:

☐ MnDOT       OR     ☑ Local Road Research Board (LRRB)

☑ Research    OR     ☐ Implementation

Need Statement Title:

Benefit/Cost of applying a higher Asphalt Film Thickness (AFT) vs doing a Chip Seal at 1 year

Need Statement: Describe the problem or the opportunity. Include background and objective.

Reducing the effects of oxidation is a continuous challenge. Two ways of doing such are:

1. Applying surface treatment over the asphalt, typically with either a fog or chip seal.
2. Increasing the asphalt film thickness (AFT) during original construction.

The University of Minnesota is currently working on a study called, Optimizing Asphalt Mixture Designs for Low-Volume Roads of Minnesota, which references film thickness (Project 2018-076). Joel Ulring is the T.L. Additionally, there was a State Aid memo entitled Guidelines for Managing Low-binder, Coarse-gradation Asphalt Pavements (December 2017).

This study should:

- Determine the pros/cons of each method.
- Determine the benefit/cost of applying a higher AFT versus a chip seal at year 1.
  - Include testing/showing test results on how much asphalt is coating each rock.
  - Determine the optimal AFT.
- Evaluate if there is a benefit of doing both at the same time.
- Determine if it is better to spend more money upfront (paying for the higher oil content) versus applying the seal coat at year 1.

Note: During the review/discussion of this Needs Statement there were several questions/statements about the effectiveness and optimal timing of sealcoats. The LRRB has recently funded a few studies on sealcoats, timing and effectiveness. They have been included in the next section of this Needs Statement.
How does this project build upon previous research (include title or reference to a completed research effort)?

<table>
<thead>
<tr>
<th>Research Effort</th>
<th>Principal Investigator</th>
<th>Year</th>
<th>Project #</th>
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<tbody>
<tr>
<td>Optimizing Asphalt Mixture Designs for Low-Volume Roads of Minnesota</td>
<td>Joel Ulring (651/366-3831)</td>
<td>2018-076</td>
<td>Ongoing</td>
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<tr>
<td>Impact of Low Asphalt Binder for Coarse HMA Mixes</td>
<td>Zhanping You</td>
<td>2017-27</td>
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<tr>
<td>Is Seal Coating Counterproductive or Not?</td>
<td>Zhanping You</td>
<td>2016-27</td>
<td>#462</td>
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<tr>
<td>Is Seal Coating Counterproductive or Not – Evaluation of Stripping Under Chip Seals Phase 2</td>
<td>Zhanping You</td>
<td>2016-27</td>
<td></td>
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<tr>
<td>Determination of Optimum Time for the Application of Surface Treatments to Asphalt Concrete Pavements – Phase 2 June 2008 - Project #: 2008-16</td>
<td>Zhanping You</td>
<td>2017-27</td>
<td></td>
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<tr>
<td>Examining Possible Causes of Stripping in Asphalt Pavement Under Chip Seals</td>
<td>Zhanping You</td>
<td>2017-27</td>
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Provide names to consider for a technical advisory panel:

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Literature Search: Asphalt Film Thickness vs Chip Seal at 1 Year
April 9, 2019
Prepared by: Race MoChridhe
Resources searched: TRID, RiP, Internet, Library Catalog

Literature Search Summary: There does not appear to be research directly comparing performance of chip seals with asphalt at various film thicknesses. A large number of longitudinal field studies have been performed, however, on the durability and performance over time of chip seals, and there exists a smaller body of work attempting to more reliably correlate asphalt film thickness (AFT) with pavement performance generally, as well as to compare the long-term effects of varying thicknesses. Notable studies with the last ten years in both of these areas are summarized below.

Effects of Asphalt Film Thickness on Field Performance
Source: Transportation Research Board 90th Annual Meeting
Date: 2011
Abstract: The overall consensus ... agrees sufficient aggregate coating promotes durability of asphalt mixtures. However, many disagree on which mix parameter best controls durability in design and production. ... To date, no studies have conclusively quantified the effect of these parameters on long term durability in the field. Though this study did not explore permeability, analysis of 458 pavement sections over a 9 year period overwhelmingly confirm a direct relationship between durability and AFT while no such conclusion can be made for VMA. Sections with an AFT less than 8.0 microns had a 75% to 95% probability of severe surface raveling within 9 years. As AFT approached 9.0 microns, the probability decreased to less than 20%. Results also indicate AFT significantly affected the rate and severity of flushing, while VMA had a significant impact on rate only. AFT was also found to significantly affect resistance to severe rutting, while the effect of VMA was limited. Both fatigue resistance and fatigue severity was significantly influenced by AFT only. It is recommended that AFT be specified between 9 and 12 microns to ensure durability and prevent flushing. Agencies not using the Iowa AFT equation should increase the recommended range.
Access Online: https://trid.trb.org/View/1093485

Evaluating Effect of Film Thickness on Aging of Asphalt Through Thin Film Oven Test
Source: Proceedings of the 3rd European Pavement & Asset Management Conference
Date: 2008
Abstract: https://trid.trb.org/View/1084595
Access Online: On many sections of State highways in hilly regions of India, premature crack formation is invariably reported. Aggregate gradation of the cores taken for investigation revealed that gradation in field was generally different from the recommended in job mix formula prepared in the laboratory. The field gradation was on finer side, which resulted in lower asphalt film thickness on aggregates. Findings of initial investigations indicated that excessive hardening (aging) of asphalt binder in wearing courses was the reason for premature cracking. Variation in aggregate gradation and asphalt content in field from design job mix can lead to variation in asphalt film thickness over aggregates, which will affect the aging of binder and thereby the performance of pavement. Therefore, effect on aging of asphalt binder (short-term aging) due to variation in asphalt film thickness was studied with the help of Thin Film Oven (TFO) test, Dynamic Shear Rheometer (DSR) and other consistency tests, and results are discussed. For the covering abstract see ITRD E144473.
Investigation of In-Place Asphalt Film Thickness and Performance of Hot-Mix Asphalt Mixtures
Research Need Statement 597

**Publisher:** Journal of Materials in Civil Engineering  
**Date:** 2019

**Abstract:** This research work investigates approaches for computing the average asphalt film thickness in asphalt mixtures and examines whether the in-place asphalt film thickness has a rational relationship with the performance of hot-mix asphalt mixtures. ... Field performance data from MnROAD and rutting data from laboratory fabricated mixtures, including both coarse and fine gradations, were analyzed to investigate the asphalt film thickness and corresponding performance of asphalt mixtures. Both the field data and laboratory experimental results show that the asphalt film thickness is a significant factor affecting the rutting performance for asphalt mixtures. However, more research work is needed to investigate the relationship between the asphalt film thickness and the other performance parameters of asphalt mixtures, such as fatigue cracking, before a film thickness specification can be proposed.  
**Access Online:** [https://trid.trb.org/View/890927](https://trid.trb.org/View/890927)

**Field Evaluation of Asphalt Film Thickness as a Design Parameter in Superpave Mix Design**  
**Publisher:** Taoyuan Chinese Society of Pavement Engineering  
**Date:** 2009

**Abstract:** Research shows that mix performance is related to asphalt film thickness (AFT). ... In this study, there is comparison of the voids in mineral aggregate (VMA) and AFT as mix design parameters against Superpave mix field performance. ... Field cores were obtained from flushed and non-flushed sections for Superpave specification compliance. Research results related mix design parameters to AFT but showed that, depending on calculation method, as a mix design parameter, AFT may or may not be helpful in explaining rutting, bleeding, and other specific field performance distresses.  
**Access Online:** [https://trid.trb.org/View/904170](https://trid.trb.org/View/904170)

**Stripping Under Chip-Sealed Pavements in Minnesota**  
**Publisher:** TRB Committee AFD60  
**Date:** 2018

**Abstract:** In 2013, the Minnesota Department of Transportation (MnDOT) conducted a preliminary study that identified high air voids in underlying asphalt pavements as the main cause of stripping under chip seals. This paper details a research project sponsored by the Minnesota Local Road Research Board (LRRB) to follow-up on and extend the 2013 MnDOT study. The research included observation, testing, and analysis of 18 chip-sealed roadways in eight cities and counties in Minnesota. Field studies included surveys of pavement density (using ground-penetrating radar and nuclear gauge tests). Laboratory tests were also conducted to assess permeability, stripping, tensile strength ratio, asphalt film thickness, and mix properties. A major outcome of the research was the inability to verify the earlier MnDOT finding that high air voids were a cause of stripping under chip seals. The study also observed no direct relationship between incidence of stripping and asphalt pavement density and stripping. In addition, the study found no evidence to support correlations between incidence of stripping and site/supplier data (e.g. bituminous mixture, contractor, geographic location, or year of construction). Conclusions and recommendations from this broad, detailed exploration of stripping in chip sealed pavements are presented in the paper to inform city and county engineers on the use of chip seal treatments in municipal roadways.  
**Access Online:** [https://trid.trb.org/View/1494281](https://trid.trb.org/View/1494281)  
[https://rosap.ntl.bts.gov/view/dot/34255](https://rosap.ntl.bts.gov/view/dot/34255) [Earlier version of paper available OA]
Chip Seal Aggregate Evaluation and Successful Roads Preservation
Publisher: Construction and Building Materials 180, pp. 396–404
Date: 2018
Abstract: This study gathers two years of field performance data (June 2014–June 2016) from chip seal projects constructed in Oregon. The data includes laboratory and field-testing to assess chip seal materials used in construction and tracks the performance of the chip seal pavements, both emulsified asphalts and hot-applied asphalts. Findings show that chip seals constructed with good quality materials enhance the surface texture properties and reduce the appearance of distresses over the two-year monitoring period for most sections.

Field Performance of Chip Seals for Pavement Preservation
Publisher: Transportation Research Record 2672(12)
Date: 2018
Abstract: As part of the National Center for Asphalt Technology Pavement Preservation Study, chip seal test sections were placed in a low traffic volume road (Lee County Road 159) in Auburn, Alabama. The location consists of a two-lane county road that provides dead end access to a quarry and an asphalt plant, resulting in a high percentage of heavy loads. At the time of treatment, the existing pavement was 14 years old and consisted of a 5.5 in. hot-mix asphalt layer over a 6.0 in. granular base. Treatments were applied in the summer of 2012 and have been in service for approximately 4.5 years. During this time, cracking, roughness, rutting, and macrotexture data were collected weekly to evaluate pavement performance. The results determined that the performance of the treated sections is highly dependent on the initial condition of the pavement, particularly the percentage of area cracked. Pavements that are treated while still in good condition tend to remain in that category for a longer time. Macrotexture may also be used to evaluate the functional performance of the chip seals.
Access Online: https://doi.org/10.1177%2F0361198118768531

Performance and Cost-Effectiveness of Chip Seal in Louisiana
Publisher: TRB Committee AHD18
Date: 2018
Abstract: This study aims at evaluating the short and long-term effectiveness of this treatment method in hot and humid climates such as Louisiana. Field performance of 24 pavement sections was used to evaluate the effects of chip seal on random cracking, roughness, rutting as well as on the overall condition of the pavement. Results showed that chip seal is very effective in controlling random cracking, but it had no significant effects on surface roughness. Pre-treatment conditions and the thickness of the Asphalt Concrete (AC) layer had significant effects on the performance of chip seals as well as on the extension of pavement service life. Pavements with AC layer thickness less than 4 in. exhibited an average service life extension of 2.6 years, whereas pavements with AC layer thickness greater than 4 in. had an average service life extension of 4.1 years. Results also showed that chip seal should not be applied to pavements with pre-treatment random cracking index (RNDM) values greater than 90 to ensure the positive effects of this maintenance activity. All the projects were found to be cost-effective, where the Benefit/Cost (B/C) ratios ranged from 1.1 to 11.3. Chip seal was more cost-effective when applied to pavements with fair to good pre-treatment conditions as compared to pavements with significant age-related distresses.
Access Online: https://trid.trb.org/View/1494478