MnDOT Pavement Preservation Manual

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MnDOT Pavement Engineer **Date**

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CHAPTER 1 – INTRODUCTION

Introduction

This document provides information regarding the use of pavement preservation strategies for maintaining pavement condition, and should be used throughout the Department. This manual discusses strategies found in Pavement Management's Highway Performance Management Applications (HPMA) decision trees as well as some that are not yet included in the decision trees. HPMA is a good network level analysis tool; treatment specific decisions are made at the District level.

Portions of this document were adopted from the manuals of the South Dakota and Illinois Department of Transportation and are included with permission.

100 – Definitions

Many transportation agencies use pavement preservation programs to cost-effectively manage their pavement assets. Pavement preservation procedures have been in use for many years, but often agencies use the same pavement preservation terminology in different manners. The Federal Highway Administration (FHWA) provided guidance regarding preservation in a Memorandum dated February 25, 2016. This memo can be found here:

FHWA Pavement Preservation Guidance Memo

The memorandum defined several preservation related terms including:

- Preservation
- Maintenance
    - Routine
    - Preventative

These terms are described in more detail in the following sections.

Preservation

Preservation consists of work that is planned and performed to improve or sustain the condition of the transportation facility in a state of good repair. Preservation activities generally do not add capacity or structural value, but do restore the overall condition of the transportation facility.

Maintenance

Maintenance describes work that is performed to maintain the condition of the transportation system or to respond to specific conditions or events that restore the highway system to a functional state of operation. Maintenance is a critical component of an agencies asset management plan that is comprised of both routine and preventative maintenance.

Routine Maintenance

Routine maintenance encompasses work that is performed in reaction to an event, season, or over all deterioration of the transportation asset. This work requires regular reoccurring attention.

Preventive Maintenance

Preventive maintenance is a cost effective means of extending the useful life of the roadway.

CHAPTER 2 – INTRODUCTION TO PAVEMENT PRESERVATION

Introduction

The intended purpose of a pavement preservation program is to maintain or restore the surface characteristics of a pavement and to extend the service life of the pavement. However, preservation does not generally increase structural value or add capacity to the pavement. As a means of improving the functional condition of the network and reducing the overall rate of deterioration of the pavement asset, preventive maintenance treatments are used in the pavement preservation program. They are relatively inexpensive in comparison to rehabilitation or reconstruction projects. Preventive maintenance treatments are an effective means to preserve the investment in the pavement asset.

200 – Objectives of Preservation

The implementation of a pavement preservation program is good practice, as it focuses on maximizing the condition and life of a network of pavements while minimizing the network's life-cycle cost. The noted benefits from the use of a pavement preservation program vary from agency to agency, but have been documented as including:

1. Improved pavement performance - preservation activities extend the performance of the pavement and help to improve the overall condition of the transportation system.

2. Higher customer satisfaction - the use of preservation activities can lead to smoother roads and fewer construction delays.

3. Increased cost effectiveness - timely treatments that extend the service life of a pavement reduce the overall life cycle cost.

4. Increased safety - preventive maintenance treatments are designed to provide safer surfaces in terms of improved pavement texture and correction of safety related defects such as ruts, low surface friction, and poor surface drainage.

A successful pavement preservation program relies on proper treatment selection and timing of the treatment to be successful. In order to select the right treatment for the right pavement at the right time, the following should be known (Peshkin et al. 2004):

- What is the structure and condition of the existing pavement?
- What is the expected performance of the pavement?
- How will different treatments affect the pavement's performance?
- What other factors affect how the treatments will perform?

These questions are best answered by information that is available in MnDOT HPMA, field reviews, and discussions with maintenance forces. The pavement management system is a set of tools or methods that assist decision makers in finding optimum strategies for evaluating and maintaining pavements in serviceable condition over a period of time. Pavement management, in the broad sense, includes all the activities involved in the planning, programming, design, construction, maintenance, and rehabilitation of the pavement portion of a public works program (Haas et al. 1994).

Details of MnDOT's Pavement Management unit can be found at the MnDOT Pavement Management Unit Website.

CHAPTER 3 – PRESERVATION TREATMENT SELECTION GUIDELINES

Introduction

In this section, MnDOT's preservation treatment selection guidelines and types are defined. It is important to note that this Manual will only discuss treatments on flexible pavements. Rigid preservation treatment inquiries should be addressed directly with the Concrete Office. Future proposed improvements include alternatives for rigid preservation treatments and a selection process.

300 – Treatment Selection Guidelines

Preservation treatments are determined based upon the combination of the current condition of the pavement and the types of distresses present. In some cases, combinations of preservation strategies are needed to correct the combination of distress that is present on the pavement. The process of selecting the combination of treatments for preservation includes the following general steps:

- Gather pavement information
- Assess pavement condition
- Evaluate pavement data

- Identify feasible preservation treatments
- Select preservation treatment

Pavement management currently has decision trees that are integrated into the HPMA software to help choose the pavement preservation strategies to maintain the condition of the pavement.

Gather Pavement Information

Selecting preservation techniques includes the collection of pavement information such as pavement construction history, pavement performance data, pavement design life, condition data, traffic data, and information about the structural design of the pavement.

Some of this information is included in the HPMA software, which is a good tool for gathering preliminary information on project sections.

The pavement type dictates the choice of treatment, as different techniques are best for various surface types. In addition to pavement type, the age and design life of the pavement can provide insight into how the pavement has performed over time and how it can be expected to perform in the future. If the pavement is near the end of its design life, it may be an indication that preservation will be less cost effective. Traffic level information, specifically the number of heavy trucks, is a critical detail for determining which treatments to use. Knowing the existing pavement structure and material properties can also be very useful to determine what treatments will work well with the current structure and how the pavement section might perform in the future.

Assess Pavement Condition

In addition to gathering historical pavement information, the current condition of the pavement must be assessed in order to determine feasible preservation treatments. Ideally the condition would be determined in the form of a standard condition rating procedure to include details of the types, severities, and amounts of all distresses present on the pavement. MnDOT's Pavement Distress Identification Manual is located at the MnDOT Pavement Management Website.

The MnDOT Pavement Management Unit performs visual surveys on all state highways and interstate routes using pavement management collection vans. Most distresses are recorded for the first 500 feet of every mile. IRI and rutting are measured continuously. This survey identifies and documents the type, extent and severity of a variety of pavement distresses. Distress data is reported in MnDOT's Pavement Management software, HPMA. It is critical to select a treatment type that is capable of correcting or improving the existing pavement distresses. For more information on how Pavement Management Unit collects data, see the Pavement Condition Rating Overview at the MnDOT Pavement Management Website.

Other critical details needed to complete an assessment of the pavement include a field review, non-destructive testing (Falling Weight Deflectometer (FWD), friction, etc.), and interviews with maintenance personnel familiar with the road.

Evaluate Pavement Data

In order to determine whether a pavement section is a good candidate for pavement preservation treatments, the following should be considered:

- Are there excessive distresses (large quantities and/or severe levels of distress) on the pavement section or are the distresses a warning sign of an underlying structural problem?
- Has the time for applying a pavement preservation treatment while it is in "good" condition passed?
- Are there other known problems (e.g., material problems, utility issues, drainage issues, or signs of construction problems)?
- Is there a history of pavement problems in this location?

If the answer to the majority of these questions is "no," then the pavement section is likely to be a good candidate for pavement preservation techniques. When the answer to most of these questions is "yes," preservation techniques should not be considered. Instead, more investigation is needed to determine other rehabilitation options.

Identifying Feasible Preservation Treatments

The treatment strategy for those pavement sections identified as candidates for pavement preservation can be determined by looking at the type and severity of pavement distresses present on the pavement. Guidelines for determining recommended and feasible treatments are provided in Figure 3.00. Guidance for treatment selection is based upon attributes such as distress levels, ride quality, surface friction, traffic levels, and relative cost. These characteristics are primarily based on a relationship between a single treatment and a single distress. When multiple distresses exist, the treatment to address each distress type should be examined and the recommended treatments must be used in combination with engineering judgment to make final treatment decisions. It should be noted that regional pricing, availability of qualified contractors, and availability of materials may also play a role in the selection of preservation treatments.

Pavement Conditions	Severity Level[1]	Crack Filling	Crack Sealing	Micro-Surfacing*	Chip Seal	Thinlay*	Thin HMA Overlay*	UTBWC*	Rut Filling	Micro Milling	Fog Seal	Mastic
Transverse Cracking	Low											
	Medium											
	High											
Longitudinal Cracking	Low											
	Medium											
	High											
Longitudinal Joint Cracking	Low											
	Medium			**								
	High			**								
Multiple Cracking	Low											
	Medium											
	High											
Alligator Cracking	Low											
	Medium											
	High											
Rutting	Low											
	Medium											
	High											
Raveling and Weathering	Low											
	Medium											
	High											
Patching	Low											
	Medium											
	High											
RQI	3.0 - 4.0											
	2.0 - 2.9											
	1.0 - 1.9											
ADT	<2,500											
	2,500 - 10, 000											
	> 10,000											
Friction	Poor											

Notes

* These treatments require ADA compliance as part of the project.

** Feasible when using a special application box to apply directly to the longitudinal joint.

1 - For more information on severity levels, please see the MnDOT Pavement Distress Identification Manual
http://www.dot.state.mn.us/materials/manuals/pvmtmgmt/Distress_Manual.pdf

Legend

Recommended

Feasible

Not Recommended

Figure 3.00: Treatment Selection Guidelines for Flexible Pavements

Select the Best Preservation Treatment

Of the feasible preservation treatments, the best treatment is one that can provide the best cost to benefit ratio while meeting the objectives of the project. There are several methods to identify the treatment with the most benefit for the associated cost. This analysis is done internally within many pavement management systems. Ideally, the selection of the right treatment at the right time is governed by optimization (maximizing benefits for given constraints). However, treatment selection can be accomplished through a manual assessment of the benefits versus the projected treatment cost.

In addition to the benefits and costs of the feasible treatments, the selection of the preservation treatment also includes considering the variety of project constraints that affect treatment selection. Project constraints that should be considered when selecting preservation treatments include:

- Availability of qualified contractors

- Availability of quality materials
- Agency practice or local preference
- Time (of year) of construction
- Initial costs
- User preferences
- Pavement noise
- Facility downtime
- Surface friction

The effect of these constraints will vary from project to project and should be taken into consideration as the final treatments are selected for inclusion in a pavement preservation program.

301 – Treatments

Many different pavement preservation techniques and treatments are available. These range from localized applications to treatments that are applied to the entire pavement surface. For all preservation treatments, the purpose is to minimize the effects of pavement distress or prevent them from occurring.

Commonly used preventive maintenance treatments and minor rehabilitation techniques are described in Chapter 4 HPMA Flexible Pavement Treatment Summaries. Each treatment summary is followed by pictures of the treatment. The flexible treatments that are presented are summarized in Figure 3.01. Prior to the presentation of each treatment type is a *Special Considerations* section that provides details that are applicable to a variety of treatments.

Treatments for Flexible Pavements
Crack Filling
Rout and Seal Cracks
Mastic for Void Filling
Fog Seal
Seal Coats
Micro surfacing
UTBWC
Thinlay (≤ 1”)
Mill & Thin Asphalt Overlay (≤ 2”)
Micro Milling

Figure 3.01: Pavement Preservation Treatments for Flexible Pavements

There are several special considerations that must be addressed prior to the construction of various pavement preservation techniques.

Pavement Preparation

Complete any crack treatments, spot patching, rut filling, or other required repairs prior to the placement of a preservation treatment. HPMA has smoothness and rutting numbers available for analysis. All flexible pavement sections should be evaluated for the presence of bumps greater than ½” using a 10-foot straightedge. Alternatively, the pavement management unit will provide pavement rutting and longitudinal profile data in mile and tenth of a mile averages when requested. These files will be .ppf files that can then be analyzed using ProVAL. ProVAL is a free software provided by FHWA, which can be downloaded from the Roadprofile website.

Bumps should be evaluated and ground prior to placing of the flexible treatment options that do not include milling or recycling of the pavement surface.

Special attention should be given to properly cleaning all milled materials from the pavement surface prior to applying a treatment. A properly cleaned surface is imperative in order to obtain proper bonding to the underlying pavement for all flexible surface treatments.

When crack sealing is needed prior to a preventive maintenance treatment, the crack seal should be placed at least 1.5 - 3 months in advance to minimize difficulties and conflicts between treatment types and/or contractors.

Pavement Markings

Please review Technical Memorandum No. 14-11-T-02 for guidance on type and placement procedures of striping on preservation treatments.

Traffic Control

Proper traffic control is needed to ensure acceptable cure times for the majority of treatments. Without proper traffic control after placement, damage to the preservation treatment may occur.

Treatment Sequencing

When epoxy or tape pavement marking exists, coordination of the selected treatment should be considered to maximize the life of the pavement marking.

Rumble Strips/Stripes

Please follow the following link for Guidance on Rumble Strips.

CHAPTER 4 – BITUMINOUS PAVEMENT TREATMENT AND FIELD PROCESS GUIDANCE

Introduction

This section summarizes the flexible pavement treatments that are currently found in the HPMA decision tree. The summaries will be followed by brief description of construction with some pictures. The costs in the summaries section were taken from the Pavement Design Unit's average bid prices found in the initial cost spreadsheets on their web page. This information is located at The Pavement Design Unit Webpage.

400 – HPMA Decision Tree Tables

The following Figures will be referenced in the summaries.

RQI	Functional Classification	RQI	Functional Classification
3.0	Rural Principal Interstate (RIN)	3.1	Urban Interstate (UIN)
3.0	Rural Principal Arterial (RPA)	3.1	Urban Principal Arterial Freeway (UPF)
2.8	Rural Minor Arterial (RMA)	2.8	Urban Principal Arterial (UPA)
2.8	Rural Major Collector (RMJ)	2.7	Urban Minor Arterial (UMA)
2.8	Rural Minor Collector (RMI)	2.6	Urban Collector (UCO)

Figure 4.00: HPMA RQI Triggers for Functional Classes

Good Crack Fill Candidate	
CRITERIA	**NOTES**
Age since Last Rehab > 5 but ≤ 8 and	
Moderate Transverse Cracking ≤ 50% and	Less than 25 mod. severity transverse cracks in 500’ (or crack spacing of more than 20 ft)
No High Severity Longitudinal Cracking and	
No High Severity Transverse Cracking and	
Low Severity Transverse Cracking ≥ 13% and	More than 6.5 low severity transverse cracks in 500’ (or a crack spacing of less than 75 ft)
Total Transverse Cracking < 40% and	Less than 20 transverse cracks, any severity, in 500’ (or a crack spacing of more than 25 ft)
Last Maintenance Activity not a Crack Seal and	
Last Maintenance Activity not a Crack Fill	

NOT a Good Crack Fill Candidate	
CRITERIA	**NOTES**
Age since Last Rehab ≤ 5 or >8 or	
Moderate Transverse Cracking > 50% or	More than 25 mod. severity transverse cracks in 500’ (or crack spacing less than 20 ft)
Any High Severity Longitudinal Cracking or	
Any High Severity Transverse Cracking or	
Low Severity Transverse Cracking < 13% or	Less than 6.5 low sev. Trans. cracks in 500’ (crack spacing of more than 75 ft)
Total Transverse Cracking ≥ 40% or	More than 20 total trans. cracks, any severity, in 500’ (crack spacing of less than 25 ft)
Last Maintenance Activity a Crack Seal or a Crack Fill	

Figure 4.01: Crack Fill Candidates

Good Crack Seal Candidate	
CRITERIA	**NOTES**
Age since Last Rehab > 2 but ≤ 5 and	
Moderate Severity Transverse Cracking ≤ 4% (if BOC pavement Mod. Sev. Trans. ≤ 10%) and	Less than 2 Mod. Sev. Transverse cracks in 500' (if BOC: Less than 5 Mod. Sev. Trans. cracks in 500')
Low Severity Transverse Cracking ≥ 13% and	More than 6.5 low sev. Trans. Cracks in 500' (crack spacing of less than 75 ft)
Total Transverse Cracking < 40% and	Less than 20 total transverse cracks, any severity, in 500' (crack spacing of more than 25 ft)
Last Maintenance Activity not a Crack Seal and	
Last maintenance Activity not a Crack Fill and	
Not a Saw & Seal Project	

NOT a Good Crack Seal Candidate	
CRITERIA	**NOTES**
Age since Last Rehab ≤ 2 or > 5 or	
Moderate Severity Transverse Cracking > 4% (if BOC pavement Mod. Sev. Trans. > 10%) or	More than 2 mod. Sev. Transverse cracks in 500' (BOC: more than 5 mod. Sev. Trans. cracks in 500')
Low Severity Transverse Cracking < 13% or	Less than 6.5 low sev. Trans. cracks in 500' (crack spacing of more than 75 ft)
Total Transverse Cracking ≥ 40% or	More than 20 total trans. cracks, any severity, in 500' (crack spacing of less than 25 ft)
Last Maintenance Activity a Crack Seal or	
Last Maintenance Activity a Crack Fill or	
Saw & Seal Project	

Figure 4.02: Crack Seal Candidates

401 – Crack Filling

Crack filling is effective at reducing or delaying moisture damage, further crack deterioration, and roughness. Crack filling is typically used for non-working cracks.

Specifications: Special Provision 2331 Bituminous Pavement Crack Treatment

Costs: $130 per road station (RDST).

$3,400 per lane mile

$1,130 - $3,400 per lane mile year

This does not include mobilization, traffic control, and striping.

Treatment Description: Crack filling is the process of placing material into working/non-working cracks to substantially reduce infiltration of water. Crack Filling is characterized by minimal crack preparation and the use of bituminous filler materials.

Crack Filling Crew and Equipment: A broom operator, air compressor operator, driver pulling an air compressor, a heat lance operator, a truck and driver pulling a melter, a wand operator applying filler, crew member placing cover material to prevent tracking, and flaggers / traffic control as deemed necessary.

Pavement Conditions Addressed: Reduces moisture infiltration to the base and subgrade through cracks. Only practical if the extent of cracking is minimal and if there is little to no structural cracking. Adds no structural benefit.

Construction Considerations: Placement should occur during moderate, dry weather conditions. Application during Spring and Fall weather, when cracks are at a moderate width, allows the filler material to expand and contract. Application should be avoided when roadbed moisture exists. Proper crack cleaning and drying are essential to achieve good bonding between the sealant and the crack walls.

FHWA Construction Inspection Checklist:

The FHWA Pavement Preservation Checklist Series is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

HPMA Recommends Crack Filling:

- Last rehab an overlay or rehabilitation
- Rutting measured in less than 10% of mile section and is 0.5 inches or less in the left wheel path
- A good crack seal or crack fill candidate (see Figures 4.01 and 4.02)
- RQI greater than the trigger (varies based on functional classification of the road, see Figure 4.00)

Alternatives to Crack Fill:

- Rout and Seal

Estimated Performance Period: 1 to 3 years

Step 1. A typical good candidate for a crack fill application.

Step 2. Cleaning and drying. Cracks must be clean and dry to facilitate sealant bonding. A heat lance is recommended after cleaning to help facilitate adhesion of the sealant material.

Step 3. Material application. This photo shows the application of sealant using a "simple band-aid" configuration. A squeegee should be used to provide a 1" to 3" overband on each side of the crack.

Step 4. Application of blotter. For hot applied materials, typical procedure is to use a single ply of toilet tissue to prevent tracking. Another option for a blotter coat is to use sand to reduce "tracking" of the material by vehicle tires.

Figure 4.03: General Crack Fill Construction Steps

402 – Rout and Seal Cracks

Routing and sealing of cracks is effective at reducing or delaying moisture damage, further crack deterioration, and roughness.

Specifications: Special Provision 2331 Bituminous Pavement Crack Treatment

Costs: $140.00 per road station

$3,700 per lane mile

$925 - $1,850 per lane mile year

This does not include mobilization, traffic control, and striping.

Treatment Description: Routing (¾" x ¾") and sealing of cracks is the process of placing flexible material into "working" cracks (i.e., those that open and close with changes in temperature) in order to reduce water infiltration into a pavement. In contrast to crack filling, routing and sealing of cracks requires more substantial crack preparation procedures and uses sealant materials with greater elasticity. Thermosetting and thermoplastic materials are both used for crack sealing.

Crack Rout and Seal Crew: Router operators, a broom operator, air compressor operator, driver pulling an air compressor, a heat lance operator, a truck and driver pulling a melter, a wand operator applying sealant, crew member placing the cover material to prevent tracking, and flaggers / traffic control as deemed necessary.

Pavement Conditions Addressed: Adds no structural benefit, but does reduce moisture infiltration through cracks. Only practical if extent of cracking is minimal and if there is little to no structural cracking.

Construction Considerations: Placement should occur during moderate, dry weather conditions. Application during Spring and Fall weather, when cracks are at a moderate width, allows the sealant material to expand and contract. Application should be avoided when roadbed moisture exists. Proper crack cleaning and drying are essential to achieve good bonding between the sealant and the reservoir walls.

FHWA Construction Inspection Checklist:

The FHWA Pavement Preservation Checklist Series is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

HPMA Recommends Rout and Crack Seal:

- Last rehab an overlay or rehabilitation
- Rutting measured in less than 10% of mile section and is 0.5 inches or less in the left wheel path
- A good crack seal or crack fill candidate (see Figures 4.01 and 4.02)
- RQI greater than the trigger (varies based on functional classification of the road, see Figure 4.00)

Alternatives to Rout and Crack Seal: Crack Fill

Estimated Performance Period: 2 to 4 years

Step 1. Crack Routing. A uniform sealant reservoir increases the probability of a neater, better performing sealant installation.

Step 2. Cleaning and drying. Cracks must be clean and dry to facilitate sealant bonding.

Step 3. Material application. This photo shows the application of sealant using a "single fill flush" configuration.

Step 4. Application of blotter. For hot applied materials, typical procedure is to use a single ply of toilet tissue to prevent tracking. Another option for a blotter coat is to use sand to reduce "tracking" of the material by vehicle tires.

Figure 4.04: General Rout and Seal Construction Steps

403 – Mastic for Crack and Pothole Repair

Mastic is a hot-applied asphalt based product combined with aggregates, polymers, and other modifiers to produce a flowable, load-bearing material that can be used to fill voids in the road surface.

Special Provision: 2331 Mastic for Void Filling

Costs: $2.00 - $3.00 per pound

This does not include mobilization, traffic control, and striping.

Treatment Description: Mastic is a hot-applied blend of asphalt material, aggregates, polymers, and other modifiers. It is designed to fill minor voids in the road surface while temporarily sealing the surface from moisture intrusion. Mastic is applied from a thermostatically controlled mixer to a pour box that bridges the void area, leaving a level finish. Mastic is typically used to level cracks that have become cupped due to erosion of the underlying base material, but can also be used to fill other minor voids such as small potholes. Due to the stiff nature of mastic compared to traditional crack sealant, cracks will typically reflect through the mastic between one and three years after its application, but the mastic will remain effective at leveling surface voids.

Crew: Laborers as needed to operate the air compressor, operate the heat lance, apply primer material, fill the mastic pour box, and apply the mastic. Traffic control/flaggers as needed.

Pavement Conditions Addressed: Mastic is effective at improving poor ride quality by leveling cupped cracks and voids in the roadway.

Construction Considerations: Similar to traditional crack treatments, a successful mastic application requires the surface to be cleaned of loose debris and vegetation with an air compressor and dried with a heat lance. If recommended by the manufacturer, a conditioner or primer is then applied to the void before applying the mastic. If necessary, the mastic may need to be applied in two lifts to achieve a level finished surface. Mastic needs a good, solid surface to bond to, therefore the existing surface should be structurally sound and not heavily raveled or deteriorated. Mastic manufacturers have different limitations on lift thickness and depth of repair. Consult the manufacturer's installation instructions for more information. A list of approved mastic products can be found in Special Provision 2331 – Mastic for Void Filling.

HPMA Mastic Recommendations:

Mastic is not currently in the decision tree.

Performance Period:

2 – 8 years

Step 1. Prepare surface. Use air compressor and heat lance to remove moisture, debris, and vegetation.

Step 2. Prime the area to be treated if recommended by manufacturer.

Step 3. Use the pour box to apply a level and uniform band of mastic.

Figure 4.05 General Mastic Construction Steps

404 – Fog Seal

A fog seal is a light application of emulsified asphalt such as CSS-1h or CRS-2Pd. It can be applied to bituminous shoulders, rumble strips, parking lots, recreational trails, or over the top of chip seals.

Specification: 2355 Bituminous Fog Seal

Costs: $2.50 - $3.00 per gallon ($0.13 - $0.60 per square yard)

$915 - $4,225 per lane mile

$230 - $2,100 per lane mile year

This does not include mobilization, traffic control, and striping. Lane mile costs heavily influenced by factors such as application rate and existing roadbed condition.

Treatment Description: CSS-1h or CRS-2Pd asphalt emulsion is applied directly to the bituminous pavement surface at a rate of 0.05 to 0.20 gallons per square yard, depending on the level of raveling and porosity of the existing pavement. The more raveled or porous the pavement surface, the higher the application rate must be. The fog seal must be allowed to fully cure before opening the road to traffic in order to prevent tracking of fog seal and fog seal spraying onto vehicles.

Crew: A broom operator to prepare the surface, distributor operator, and traffic control as needed.

Pavement Conditions Addressed: Fog Seals do not add structural capacity, but will provide benefits to pavement distresses like raveling/weathering (loose material must be removed), moisture infiltration, and low severity cracking. Prior to treatment, it may be necessary to perform other treatments to address other issues, such as rut filling, patching, crack treating, or spray patching.

Construction Considerations: A successful fog seal requires a clean and dry existing surface, therefore the sweeping operation prior to applying the emulsion is very important. A light coating of sand may be applied on top of the fog seal to improve surface friction. Fog seals will only temporarily seal very fine cracks. Crack treatment should be performed prior to fog sealing if medium or high severity cracks are present in the existing roadway. Fog seal must be applied prior to placement of any pavement markings. Existing pavement markings will have to be

protected during or replaced after fog seal application. Fog seals are an effective treatment for paved shoulders, rumble strips, parking lots, recreational trails, and can be applied over the top of chip seals.

FHWA Construction Inspection Checklist:

The FHWA Pavement Preservation Checklist Series is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

HPMA Fog Seal Recommendations:

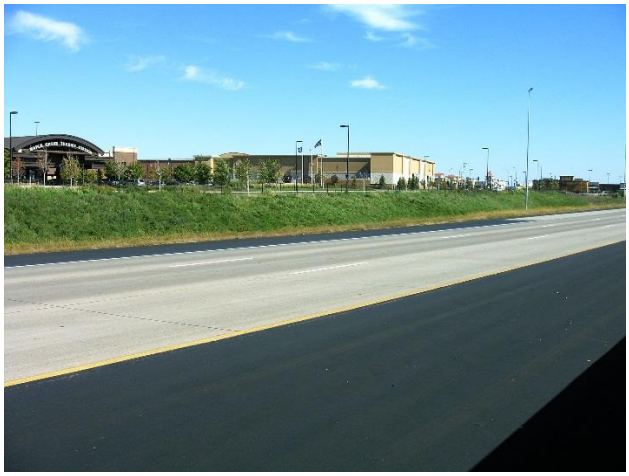
Fog Seal is not currently in the decision tree.

Performance Period:

2 – 4 years

Step 1. Surface is Swept Clean.

Step 2. Fog seal is applied to pavement surface. The example above shows a fog seal applied to a bituminous shoulder.



Step 3. Fog Seal must be allowed to cure.

Figure 4.06: General Fog Seal Construction Steps

405 – Seal Coat

Seal coats are effective at improving poor friction, inhibiting raveling, correcting minor roughness and bleeding, and sealing the pavement surface.

Specifications and other Information: 2356 Bituminous Seal Coat

Additional information about seal coats can be found in the Minnesota Seal Coat Handbook.

Seal Coat Design Software can be used to determine target emulsion and aggregate application rates.

The following link shows a short video about applying a seal coat at MnROAD.

Costs: $1.85 per square yard

$13,000 per lane mile

$1,860 - $2,600 per lane mile year

This does not include mobilization, traffic control, and striping.

Production Rate: 10 – 12 centerline mile per day

Treatment Description: CRS-2P asphalt emulsion is applied directly to the pavement surface followed by the application of aggregate chips, which are then immediately rolled to embed chips. Application rates depend upon aggregate gradation and maximum size.

Seal Coat Crew: An emulsion distributor operator, an operator for the chip spreader, 3-4 pneumatic tire roller operators, 3-4 broom operators, trucks as needed to bring aggregate to the project, and traffic control as needed.

At the pit there will be a loader operator to load the trucks with chips.

Pavement Conditions Addressed: Seal coats do not add structural capacity but will provide benefits to pavement distresses including low severity longitudinal, transverse, and block cracking, raveling/weathering (loose material must be removed), friction loss, and moisture infiltration. Prior to treatment placement, it may be necessary to perform other activities to address issues such as rut filling, patching, or crack treatments.

Construction Considerations: Surface must be clean. Treatment should be placed during warm, dry weather. The chip spreader must be immediately behind the asphalt distributor, with the

rollers closely behind the spreader. Pneumatic-tired rollers should make a minimum of three passes immediately after chip placement. Seal coats are placed from May 15 to August 10 in the northern part of the state and May 15 to August 31 in the southern portion of the state. The pavement and air temperatures must be 60°F and rising. Construct only in daylight hours, roads may be damp, but there must be no standing water. Do not construct in rain or foggy weather.

Sweep all pavements the same day as application. Re-sweep the following day to remove all additional loose rock.

A fog seal is recommended on all applications to reduce long term aggregate loss and potential vehicle damage. Fog seal can be placed as soon as one day after the seal coat. Latex permanent stripes can be placed 3 days after the fog seal, all other permanent markings should be placed 14 days after a fog seal.

FHWA Construction Inspection Checklist:

The FHWA Pavement Preservation Checklist Series is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

HPMA Recommends Seal Coat:

- Traffic less than 10,000 AADT
- 7 or more years since last rehabilitation and last rehabilitation not a surface treatment
- Rutting measured in less than 10% of mile section and is 0.5 inches or less in the left wheel path
- Not a good crack seal or crack fill candidate (Figures 4.01 and 4.02)
- Little or no load related distresses, less than 20’ of alligator cracking in 500 feet section, less than 100’ high severity longitudinal cracking in 500’, less than 10 high severity transverse cracks in 500 feet (crack spacing of 50’ or more), less than 100’ of multiple cracking in a 500’ section
- RQI greater than the trigger (varies based on functional classification of the road, see Figure 4.00)

Alternatives to Seal Coat:

- Micro-surfacing
- Thin lift overlay

- UTBWC

Estimated Performance Period: 5 to 7 years.

Step 1. Prepare surface. Surface must be clean. All structures (manholes, valve boxes, etc.) need to be protected prior to placement. Striping may be pre-treated with emulsion. Large pavement messages (turn arrows, RR Xing, etc.) should be removed.

Step 2 & 3. Emulsion and chip application. The asphalt emulsion is applied to the surface with a distributor truck. Chips are spread from a self-propelled, pneumatic tired unit with a hopper on the front from which the chips are placed onto the roadway.

Steps 4 & 5. Rolling and sweeping. After the application of the aggregate, the surface is rolled with pneumatic-tired rollers and swept to remove excess aggregate.

Step 6. After 24 hours, fog seal over the seal coat.

Figure 4.07: General Seal Coat Construction Steps

406 – Micro Surfacing

Micro surfacing is effective at correcting or inhibiting raveling and oxidation of the pavement surface, improving surface friction, sealing the pavement surface, and filling minor surface irregularities and wheel ruts.

Specifications: 2354 Micro Surfacing

ADA Considerations: Compliance with the Americans with Disabilities Act is required.

Costs: $2.75 - 3.50 per square yard

$19,400 - $25,000 per lane mile

$2,800 - $5,000 per lane mile year

This does not include mobilization, traffic control, and striping.

Production Rate: 7-10 center line miles per day for both scratch and surface course

Treatment Description: Micro surfacing consists of a mixture of modified emulsified asphalt, mineral aggregate, mineral filler, water, and additives. Micro surfacing material is mixed in specialized, compartmented, self-powered trucks or continuous machines and placed on the pavement using an augured screed box. It is typically placed in two courses. The first course, the scratch course, uses a steel box to fill in low areas of the pavements by "scratching" the surface. The surface course is placed with a rubber squeegee to create a smooth surface.

Micro-Surface Crew: A broom and operator, 2 people on front of the continuous machine to hook hose of the emulsion and water trucks to the machine. A micro surfacing continuous machine driver, a pug mill operator, 2 crew members on the back of the box, 1-2 people on the ground with a lute, 1 person adding the mineral filler at the top of the machine, a distributor truck operator for tack placement. Traffic control as necessary for the job.

At the pit you will see a loader operator placing aggregate in as many trucks as needed to keep the operation moving and a crew member filling the emulsion truck.

Pavement Conditions Addressed: Micro surfacing does not add structural capacity but will provide protection against surface distresses like low severity cracking, raveling/weathering (loose material must be removed), minor roughness, friction loss, and moisture infiltration. Micro surfacing will also temporarily seal cracks (if severity is low) and can serve as a rut-filler (if

the existing ruts are stable). Prior to treatment placement it may be necessary to perform other treatments to address other issues, such as rut filling, patching, crack treating, or patching.

Construction Considerations: The micro surfacing material shall be placed only when the air and pavement surface temperature is above 50°F (10°C) and rising. The weather also may not be foggy or rainy. No Micro-surfacing shall be placed when there is a danger that the finishing product will freeze within 48 hours. Micro surfacing material shall not be placed after September 15.

A 1,000 feet nighttime test strip is to be completed prior to placement of the micro surfacing, no matter if the treatment is to be constructed in day time hours. The test strip needs to be able to carry traffic within one hour of placement. Full production may begin after the test strip is approved by the Engineer.

FHWA Construction Inspection Checklist:

The FHWA Pavement Preservation Checklist Series is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

HPMA Recommends Micro surface:

- Traffic greater than 10,000 AADT
- 7 or more years since last rehabilitation and last rehabilitation not a surface treatment
- Rutting measured in less than 10% of mile section and is 0.5 inches or less in the left wheel path
- Not a good crack seal or crack fill candidate (see Figures 4.01 and 4.02)
- Little or no load related distresses, less than 20’ of alligator cracking in 500 feet section, less than 100’ high severity longitudinal cracking in 500’, less than 10 high severity transverse cracks in 500 feet (crack spacing of 50’ or more), less than 100’ of multiply cracking in a 500’ section
- RQI greater than the trigger (varies based on functional classification of the road, see Figure 4.00)

Alternatives to Micro surfacing:

- Seal Coat
- Thin lift overlay

- UTBWC

Estimated Performance Period: 5 to 7 years.

Step 1. Prepare surface. Surface must be clean. All structures (manholes, valve boxes, etc.) need to be protected prior to placement.

Step 2. Tape striping must be removed. All other striping may be pre-treated using CSS-1h. Large pavement messages (turn arrows, RR Xing, etc.) should be removed.

Step 3. Micro surfacing placement. This photo shows the placement of material using a micro surfacing spreader box.

Step 4. If the machine needs to stop, a straight edge needs to be made in the micro surfacing. Some handwork may be required to smooth edges. Excessive handwork can segregate the mix as well as leave an unsatisfactory finish.

Figure 4.08: General Micro Surfacing Construction Steps

407 – Ultra Thin Bonded Wear Course (UTBWC)

An ultra-thin bonded wearing course (UTBWC) is a gap-graded thin hot mix asphalt surface course. It effectively addresses minor surface distresses and increases surface friction.

Specifications: 2353 Ultrathin Bonded Wearing Course (UTBWC)

ADA Considerations: Compliance with the Americans with Disabilities Act is required.

Costs: $5.00 per square yard

$35,200 per lane mile

$2,930 - $5,030 per lane mile year

This does not include mobilization, traffic control, and striping.

Treatment Description: An UTBWC is formed in one pass with the application of a heavy, polymer-modified asphalt emulsion tack coat and a gap-graded, polymer-modified 0.4 in. to 0.8 in. (10 mm to 20 mm) HMA layer. It is placed using a spray paver.

UTBWC Crew: A broom operator for sweeping prior to paving, spray paver operator, 2 men on the box, 2 crew members walking behind correcting mat with lutes, break down roller operator, pneumatic tire roller operator, and finish roller operator. Traffic control as needed for the project.

Pavement Conditions Addressed: This treatment is applicable for low-severity cracking (high severity can be addressed with cold milling), raveling/weathering (remove loose material), high-severity friction loss, low-severity roughness, and low-severity flushing/bleeding. Provides some increased capacity and retards fatigue cracking, but is not suited for rutted pavements.

Construction Considerations: This treatment requires special paving equipment to place the mix. Repair localized structural problems prior to overlay application. UTBWC courses are not recommended where structural failures exist (e.g., significant fatigue cracking, deep rutting) or if there is high- severity thermal cracking. An UTBWC is not recommended when there is extensive pavement deterioration or little remaining life. UTBWC is capable of withstanding high ADT volumes and truck traffic.

UTBWC is usually placed on top of a new mill and overlay or a micro milled surface. Occasionally it is placed directly on existing asphalt or concrete surface if the overall ride of the existing pavement is in good condition

HPMA UTBWC Recommendations:

- UTBWC is currently is not in the decision tree. It is an alternative to seal coat, micro surface, thinlays and thin-lift overlay.

Alternatives to UTBWC:

- Micro Surfacing
- Seal Coat
- Thin Lift Overlay

Performance Period: 7 to 12 years.

Step 1. Prepare surface. This can be with a mill, a micro mill, or just cleaning. Surface must be clean.

Step 2. Place the UTBWC using a spray paver and a shuttle buggy.

Steps 3. Compact the UTBWC using rollers.

Figure 4.09: General UTBWC Construction Steps

408 – Thinlays

Thinlays are a thin asphalt overlay ranging from 5/8" to 1". Thinlays were developed for structurally sound pavements that are showing signs of aging, oxidation or minor surface distresses. Thinlays are a pavement preservation technique that provide improved ride quality and address ravelling, low-severity top-down cracking and oxidation while maintaining surface geometrics. (Summarized from Thinlay Design Guidance)

Specifications:

MnDOT State Aid has developed a Thinlay Design Guidance along with two Special Provisions:

- Thinlay 2360 Special Provision
- Thinlay 3139 Special Provision

Costs: $3.00-$4.50 per square yard

$21,120-$31,680 per lane mile

$3,017-4,525 per lane mile year

This does not include mobilization, traffic control, and stripping.

Treatment Description:

Thinlays are designed as a pavement preservation tool and typically do not provide increased structural strength to the overall pavement section. Thinlays are asphalt mixes that can be placed at a thickness between 5/8" to 1" on a well-prepared surface. The pavement being overlaid may be milled or not depending on surface distresses. The pavement should not show signs of structural distress requiring a more extensive rehabilitation. The surface should be clean, and a tack coat placed prior to paving.

Crew: A broom operator for sweeping prior to tack, distributor operator to place tack, paver operator, 2 crew members on the box, 2 crew members walking behind correcting mat with lutes, break down roller operator(s), pneumatic tire roller operator(s), and finish roller operator(s). Traffic control as needed for the project.

Pavement Conditions Addressed: This treatment is applicable for pavements that are dry-looking, porous/permeable, raveled, have extensive cracking too fine for crack sealing, minor

rutting (< ¼ "), no structural (fatigue or rutting) damage and will have sufficient remaining structural capacity to last the expected life of the preventive maintenance treatment.

Construction Considerations: Adding a tack coat is critical to the existing pavement due to the thinness. A tack coat will help improve the bond to the existing surface. Thinlays dissipate heat rapidly and, therefore, depend upon minimum specified mix placement temperatures and timely compaction.

ADA upgrades will need to be included with this type of project.

FHWA Construction Inspection Checklist:

The FHWA Thin Hot Mix Asphalt Checklist provide a list of necessary items to be considered for a successful project.

Treatment Application Recommendations:

- Rutting measured in 0.10 of one-mile section and is 0.5 inches or greater in the left wheel path
- Less than 30 total transverse cracks, any severity, in 500 feet; or crack spacing of more than 17 feet
- Little or no load related distresses
    - less than 20' of alligator cracking in 500' section
    - less than 100' high severity longitudinal cracking in 500' section
    - less than 10' high severity transverse cracks in 500' section (crack spacing of 50' or more)
    - less than 100' of multiple cracking in a 500' section
- RQI greater than the 2.0
- Mill should be completed prior to the overlay on roads that have curb and gutter

Alternatives to Thinlays:

- UTBWC
- Slurry Seal
- Microsurfacing

Estimated Performance Period: 6-8 years

Step 1: Material is produced at an asphalt plant.

Step 2: Prepare surface. Mill if required, adjust manholes as needed. Surface must be clean prior to tack coat.

Step 3: Tack pavement uniformly. Protect tacked surface from dirt and debris as much as possible until placement of the overlay.

Step 4: Place bituminous overlay.

Step 5: Roll the bituminous as needed to achieve density requirements. This will be accomplished with both steel and pneumatic tire rollers.

Figure 4.10: General Thinlay Construction Steps

409 – Thin Mill and Overlay

The application of a thin mill and HMA overlay is a viable option for improving ride, surface friction, surface characteristics, and improving the profile, crown, and cross slope of a roadway. Typical depth/thickness of this application is between 1” and 2”.

Specifications: 2360 Plant Mixed Asphalt Pavement

ADA Considerations: Compliance with the Americans with Disabilities Act is required.

Costs: Mill depth of 1.0 – 1.5” is $0.75-$1.00 per square yard.

$6,125 per lane mile

1.5” Bituminous Overlay $3.25 – $6.00 per square yard.

$23,000 - $42,000 per lane mile

$2,300 - $5,250 per lane mile year

This does not include mobilization, traffic control, and striping. Pricing is heavily influenced by mix type, project quantity, and regional pricing.

Treatment Description: Plant-mixed combinations of asphalt cement and aggregate applied to the pavement in thicknesses ≤2”. Dense-graded, open-graded, and stone matrix mixes can all be used. Thin HMA overlays consists of placing a single-pass overlay on a pavement that is not in need of significant repair and is in good structural condition. If the overlay is applied at the correct time, it can delay serious distresses, extend the life of the pavement, and decrease the lifetime cost of the pavement.

Thin Overlay Crew: A broom operator for sweeping prior to tack, distributor operator to place tack, paver operator, 2 crew members on the box, 2 crew members walking behind correcting mat with lutes, break down roller operator(s), pneumatic tire roller operator(s), and finish roller operator(s). Traffic control as needed for the project.

Pavement Conditions Addressed: This will provide benefits to pavement distresses like low-severity cracking, raveling/weathering (loose material must be removed), friction loss, roughness, low-severity bleeding, low-severity block cracking (may perform better with additional milling). Thin overlays may also be used to correct rutting but will require the use of a separate rut-fill application.

Construction Considerations: Surface must be clean. A tack coat is required prior to overlay placement and will help improve the bond to the existing surface. Thin HMA overlays dissipate heat rapidly and, therefore, depend upon minimum specified mix placement temperatures and timely compaction. Any additional layer thickness must be taken into consideration to maintain proper clearance under bridges.

FHWA Construction Inspection Checklist:

The FHWA Pavement Preservation Checklist Series is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

HPMA Recommends Thin Lift Overlay:

- Rutting measured in 10% of mile section and is 0.5 inches or greater in the left wheel path
- Less than 30 total transverse cracks, any severity, in 500 feet; or crack spacing of more than 17 feet
- Little or no load related distresses, less than 20’ of alligator cracking in 500 feet section, less than 100’ high severity longitudinal cracking in 500’, less than 10 high severity transverse cracks in 500 feet (crack spacing of 50’ or more), less than 100’ of multiple cracking in a 500’ section
- RQI greater than the trigger (varies based on functional classification of the road, see Figure 4.0)
- Mill should be completed prior to the overlay on roads that have curb and gutter

Alternatives to Thin Lift Overlay:

- Micro Surfacing
- UTBWC
- Seal Coat

Estimated Performance Period: 8 to 10 years.

Step 1. Prepare surface. Mill if required, adjust manholes as needed. Surface must be clean prior to tack coat.

Step 2. Tack pavement uniformly. Protect tacked surface from dirt and debris as much as possible until placement of the overlay

Steps 3. Place bituminous overlay.

Step 4. Roll the bituminous as needed to achieve density requirements. This will be accomplished with both steel and pneumatic-tired rollers.

Figure 4.11: General Thin Lift Overlay Construction Steps

410 – Micro Milling

Micro Milling uses a milling head with about three times more teeth than a conventional milling head to remove a thin layer of the existing pavement surface and restore pavement smoothness.

Special Provision: 2232 Micro Mill Pavement Surface

ADA Considerations: Compliance with the Americans with Disabilities Act is required.

Costs: $0.75 - $1.50 per square yard

$5,280 - $10,560 per lane mile

This does not include mobilization, traffic control, and striping.

Treatment Description: The specialized milling head used in Micro Milling produces a surface that has a smoother texture when compared to conventional milling and can improve surface friction of an existing roadway. Much of the smoothness comes from the fact that the ridge to valley depth, or the difference between the lowest and highest points of the micro milled surface, is much less than that of a conventionally milled surface. The milling machine has sonic levelling equipment, usually at the front and rear of the machine that will remove some of the undulations in the pavement profile. Because of the smooth surface texture achieved, a roadway can potentially be opened to traffic after the micro milling operation is complete with no further treatment. Micro Milling is also effective in preparation for treatments such as UTBWC or Thin Lift Overlay. Furthermore, unlike with conventional milling, micro milling can be performed prior to a surface treatment such as a chip seal or micro surface. Mill depth should be limited to one inch.

Crew: A mill operator, mill spotter, haul truck to collect millings, broom operator to sweep surface after milling, and traffic control as needed.

Pavement Conditions Addressed: This treatment is applicable for low to moderate severity roughness (RQI ≥ 2.0) and high severity friction loss.

Construction Considerations: A specialized milling head with roughly triple the amount of teeth of a conventional milling head is required for Micro Milling. The milling head should be wide enough to cover an entire lane without the need for multiple passes. The forward speed of the milling machine must be slow enough and RPM of the milling head be such that all teeth across

the width of the milling head make proper contact with the existing surface. The pavement must be structurally sound. Micro Milling is not recommended where structural failures exist (e.g., significant fatigue cracking or deep rutting) or if there is high severity thermal cracking. Micro Milling is not recommended when there is extensive pavement deterioration or little remaining service life. Micro Milling is capable of withstanding high ADT volumes and truck traffic if performed on a structurally sound pavement.

HPMA Micro Milling Recommendations:

- Micro Milling is currently is not in the decision tree.
- Micro Milling is a potential alternative to thin mill and overlay when used with a Chip Seal, Micro Surface, Thin Overlay, or UTBWC.

Alternatives to Micro Milling:

- Surface treatment without milling prior to placement.
- Conventional Milling (If combined with a thin overlay or more substantial treatment.)

Estimated Performance Period:

Dependent on the treatment placed on the milled surface. Below is a chart showing the improvements in ride quality on two projects using the combination of micro mill and UTBWC.

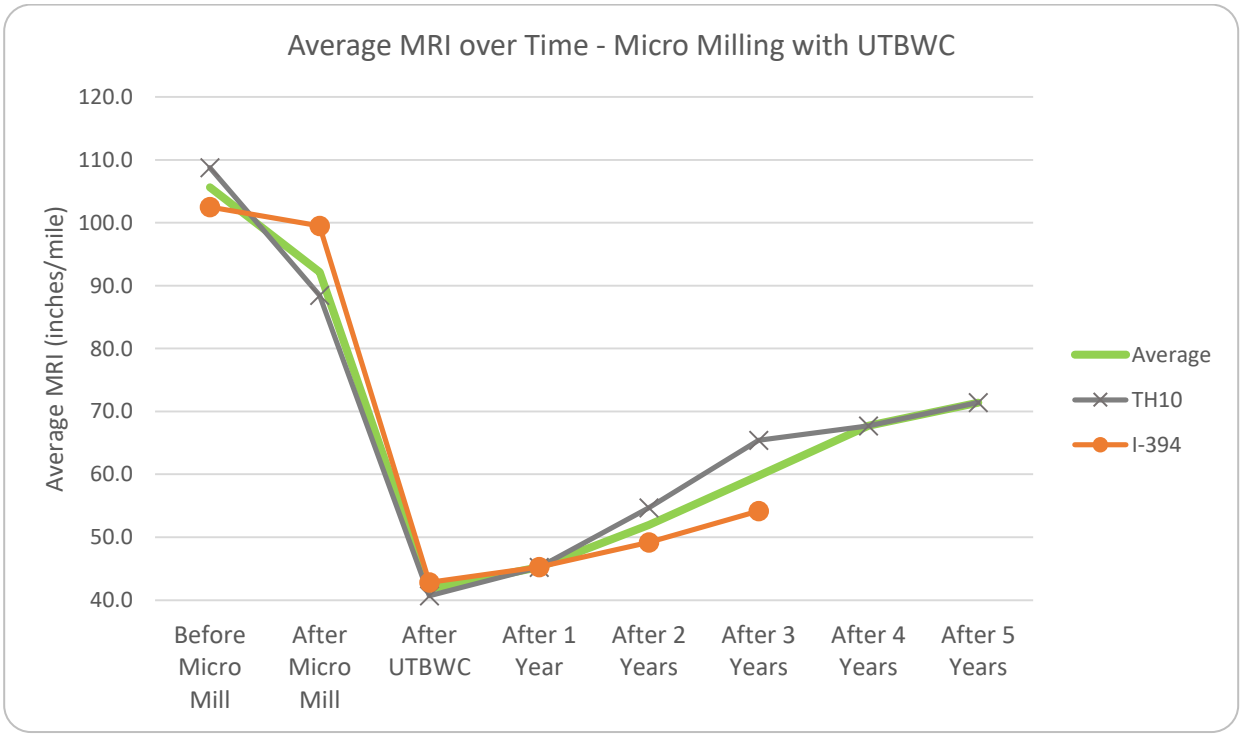


Figure 4.09: Micro Mill and UTBWC Performance

Step 1. Micro mill is performed across the entire lane width.

Step 2. Millings are collected by a haul truck.

Step 3. Milled surface is swept free of debris.

Step 4. Final texture of the micro milled surface.

Figure 4.12: General Micro Mill Construction Steps

CHAPTER 5 – SPECIAL CASE: LONGITUDINAL JOINT DETERIORATION

Introduction

One of the major distresses on Minnesota highways is the premature deterioration of the longitudinal paving joints on bituminous pavements. Longitudinal joint deterioration, also known as longitudinal joint cracking, is defined in the MnDOT Pavement Distress Identification Manual as “Cracks predominantly along the pavement centerline, lane division lines, or the lane to shoulder division.” This section will detail different severity levels of joint deterioration, as well as some of the available options to treat a deteriorated longitudinal joint. This section will also highlight some practices and treatments designed to improve longitudinal joint performance.

500 - Longitudinal Joint Deterioration Causes and Severity Levels

When a paver places the first pass of new bituminous mat, the longitudinal joint is considered unconfined if there is no structure to confine the lateral forces during compaction (such as curb and gutter). It is often difficult to achieve proper density on an unconfined joint due to the mat’s tendency to move laterally under roller compaction.

A confined edge is created when a paving pass abuts another mat, pavement surface, or curb and gutter. Confined edges typically have higher densities than unconfined edges because there is no lateral displacement of the mat during compaction. In most cases, the confined edge abuts a cooler surface. There can be bonding issues from the hot-on-cold edge but attention to workmanship and certain construction techniques can help improve longitudinal joint performance.

The MnDOT Pavement Distress Identification Manual defines three severity levels of longitudinal joint cracking, which are listed below:

Low Severity

A single crack, at least 3 feet long, parallel to the centerline of the roadway, including a crack that has been routed and sealed as long as the sealant is in good condition.

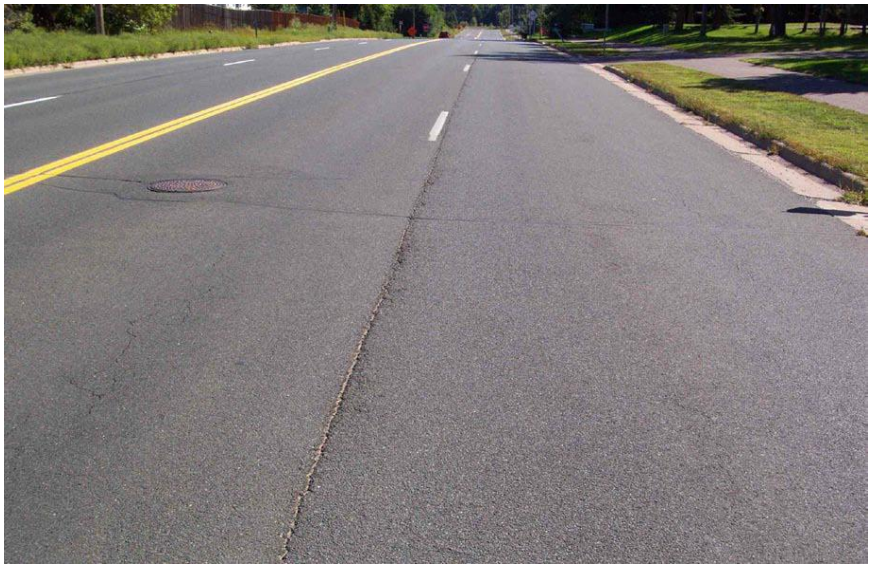


Figure 5.00 Low Severity Longitudinal Joint Deterioration

Medium Severity

Any crack running parallel to the centerline of the roadway with adjacent low severity random cracking, less than 12 inches apart. There may also be a small amount of patching or popouts. Cracks that have been repaired with hot mix or slurry materials and are in good condition are also rated as medium.

Figure 5.01 Medium Severity Longitudinal Joint Cracking

High Severity

Any crack running parallel to the centerline of the roadway with significant adjacent random cracking (12 inches or more apart), have large areas of spalling, missing material, and/or potholes.

Figure 5.02 High Severity Longitudinal Joint Cracking

501 - Longitudinal Joint Treatment Options

After longitudinal joint deterioration has begun on a road, the available treatment options will depend on the severity of the deterioration. This section will highlight possible options based on severity level.

Hot Pour Crack Sealant

If a longitudinal joint is experiencing low severity cracking, the best option is to use a hot pour crack sealant as detailed in Chapter 4. Hot pour sealant may be used to treat medium severity longitudinal joint cracking, provided there are not potholes or excessive raveling of the joint. For longitudinal cracks, MnDOT does not specify routing and sealing, only clean and seal (Crack Filling) is specified for longitudinal cracks. As with any crack treatment method, ensuring the crack is clean and dry prior to applying sealant is paramount.

Mastic

This entails applying mastic to a deteriorated joint. This treatment is often used with medium to high severity longitudinal joint deterioration. Milling out extremely spalled areas prior to treatment will yield the best results. This treatment yields relatively low production and requires at least one lane closure. Re-striping the lane markings will likely be required, as will re-cutting of rumble strips, if applicable.

Badly deteriorated longitudinal joint prior to mastic treatment.

Mastic heater used to pour material into the joint.

Box Screed used to evenly spread mastic along the longitudinal joint.

Finished appearance.

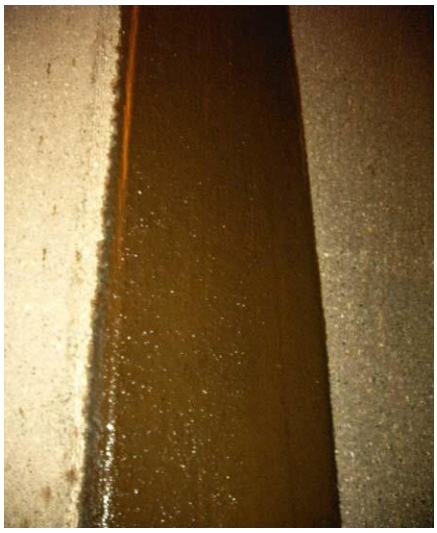
Figure 5.03 Longitudinal Joint Treatment with Mastic

Micro Surfacing

This involves using a modified micro surfacing rut box (see photos) to isolate the longitudinal joint and fill any voids and cracks, thus creating a uniform appearance along the joint. This treatment can be used on medium to high severity longitudinal joint deterioration. MnDOT typically does not perform milling prior to application of this treatment, but milling will yield longer term performance if extensive spalling is present. This method has a higher production rate than patching, but two lane closures are required since the micro surfacing machine must straddle the joint. Since this treatment is applied to the entirety of the longitudinal joint, re-striping is always needed.

Badly deteriorated longitudinal joint on I-494.

Modified micro surfacing rut box. Note the augers have been removed and a box used to straddle the longitudinal joint has been bolted into place.



Micro surfacing immediately after application to the longitudinal joint.

Finished appearance with temporary striping.

Figure 5.04 Micro Surfacing of Longitudinal Joints

Bituminous Hand Patching

This is a very labor intensive form of bituminous patching where workers shovel hot mix asphalt or cold mix patching material into potholes along the longitudinal joint. The mix is often tamped with a shovel to compact the material into place, although better compaction can be achieved by driving over the patch mix with a maintenance truck or by using a steel drum roller. Affected areas are sometimes milled prior to applying the mix, but in many cases, the mix is applied directly to the potholes without milling. Rolling traffic control can be used. The final appearance

is typically not uniform since only isolated areas are treated. Performance varies based on installation and preparation methods, but this is typically used as a short term fix until a more substantial treatment can be applied.

Pothole prior to patching with cold mix.

Laborer shovels in cold mix and tamps with shovel.

Cold mix patch about 8 months after application.

Figure 5.05 Cold Mix Hand Patching

Blow Patching

The next method of bituminous patching involves using a blow patch vehicle. This is a specialized piece of equipment that mixes emulsion and fine aggregate into a slurry, and blows this mixture into cracks, potholes, and other voids without the need for a crew of laborers. All patching is performed by the use of controls inside the blow patch vehicle. Care must be taken by the operator to apply the correct mixture of aggregate and emulsion. Too rich a mixture can result in bleeding patches that may need to be re-patched. Blow patching is typically slower

than hand patching, but is often safer since there are no laborers exposed to traffic. Traffic control is needed to protect the blow patch vehicle and operator during patch installation.

A blow patch truck.

The blow patch truck begins spraying a slurry of aggregate and emulsion into the pothole.

The slurry is used to fill the pothole.

Cover aggregate is used to protect the patch as the emulsion cures.

Figure 5.06 Blow Patching

Milling and Patching

Typically, the most durable method of bituminous patching is longitudinal milling and patching. This involves milling several inches into the longitudinal joint, spreading hot mix asphalt into the milled area, and compacting with a steel drum roller. This type of patching provides a uniform appearance and restores the structure of a badly deteriorated joint. It should be noted that this method requires two lanes to be closed and is labor intensive with low production. This treatment requires re-striping of the affected lane markings. If rumble strips are required, they will need to be re-cut as well.

A small mill is used to prepare the longitudinal joint for patching.

Milled area with tack coat prior to patching.

Asphalt is placed into the milled area and compacted with a steel drum roller.

Patched area after compaction with steel drum roller.

Figure 5.07 Milling and Patching of Longitudinal Joint

502 - Preventing Longitudinal Joint Deterioration

So far, this chapter has discussed the different severity levels of longitudinal joints as well as treatment options to repair deteriorated longitudinal joints. There are, however, some construction practices and treatments that can help minimize or delay longitudinal joint deterioration. This section will discuss some of these options.

Bituminous Mixture Selection

As discussed earlier in this chapter, longitudinal joints can be difficult to compact. A poorly compacted joint can have low air voids, potentially leading to premature joint deterioration. One way of combatting this is to select a bituminous mixture that offers ease of compaction at the longitudinal joint. There are several mixtures in particular that are more easily compacted:

Stone Matrix Asphalt

Stone Matrix Asphalt (SMA) is a bituminous mixture with a gap aggregate gradation that is designed to resist rutting and withstand high traffic volumes using a stone-on-stone aggregate structure (see the MnDOT Bituminous Manual). The asphalt content of SMA is also typically several percent higher than traditional HMA. Because of the aggregate structure, the aggregates in the mix are “seated” during the compaction process instead of being densified as in traditional HMA mixtures. This, along with higher asphalt content, makes it easier to achieve the desired density at the longitudinal joint compared to typical HMA mixtures.

Ultrathin Bonded Wearing Course

UTBWC was described in Chapter 4 of this manual. Similar to SMA, UTBWC has a gap graded aggregate structure and greater asphalt content than typical HMA. It is also compacted in a similar fashion to SMA whereby the aggregates are “seated.” UTBWC is typically placed in 5/8” to 3/4” lifts and can be used on its own as a pavement preservation treatment, or as a wearing surface over other bituminous mixtures. In either case, tight longitudinal joints are easier to achieve with UTBWC than traditional HMA mixtures.

Thinlay

Thinlay is a fine, dense graded bituminous mixture typically placed at a thickness of one inch or less. Similar to UTBWC, thinlay can be used on its own as a pavement preservation treatment or as a final wearing surface over previous lifts of bituminous pavement. In general, fine graded mixtures have been shown to be easier to compact than other dense gradations and are a good choice for creating tight longitudinal joints.

Echelon Paving

Probably the best way to eliminate the issue of hot-on-cold longitudinal joint paving passes is to pave in echelon. This involves having two pavers running at the same time with their respective paving passes butting against each other. One paver is staggered closely ahead of the other in an echelon formation. The end result is two adjacent paving passes completed at nearly the same time. If properly executed, echelon paving can produce a joint between the paving passes which is virtually indistinguishable from the center of the mat, both in terms of density and appearance.

Echelon paving comes with a host of logistical issues. To start, the Paving Contractor must have two pavers available at the same time. Additional rollers will be needed to properly compact the bituminous mat. Three lane closures (or two lane closures and a shoulder) will likely be required - two lanes for the pavers and rollers, and one lane (or shoulder) for haul trucks to access the work site. If all these requirements are met on a project, echelon paving can produce an exceptional bituminous pavement.

Tack coat is applied to both lanes prior to paving.

Two paving operations simultaneously place fresh asphalt. They are staggered in an echelon formation.

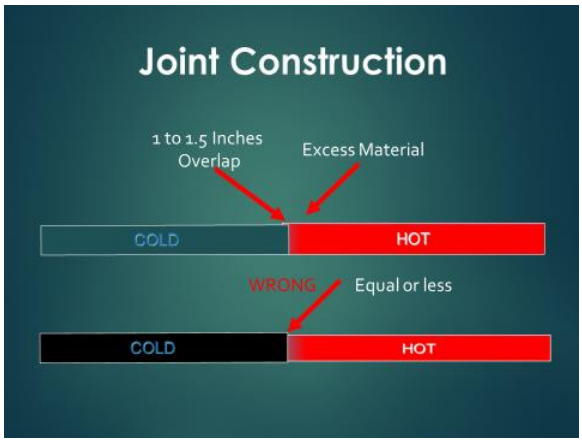
Two adjacent lanes of asphalt mat are paved at the same time.

Both lanes are then compacted with rollers.

Figure 5.08 Echelon Paving

Maryland Joint

The Maryland joint is a method of constructing a longitudinal joint whereby the second paving pass overlaps the first paving pass by 1 - 1 ½ inches. The rollers then compact over the overlapped hot mix to try and reduce any excess air voids at the longitudinal joint interface. Care must be taken so that the overlapped area is not too thick. Excessive thickness of the overlap can produce a height differential between paving passes.



A diagram detailing the Maryland joint construction method.

A finished Maryland joint. Note the area adjacent to the joint is lighter in appearance. This is the result of some of the aggregate getting crushed during compaction. This is normal with this construction method.

Figure 5.09 Maryland Joint Construction

Pavement Joint Adhesive (MnDOT Special Provision 2331)

This involves placing a rubberized, hot-applied sealant material onto the face of a longitudinal construction joint immediately prior to paving the adjacent pass. This construction method promotes bonding of the two pavement passes and is designed to improve longitudinal joint performance.

Joint adhesive being applied to the face of the longitudinal joint.

Joint adhesive after application. Note the pooled material adjacent to the joint. The adhesive material should be confined against the longitudinal joint to prevent this pooling.

Figure 5.10 Joint Adhesive Application

Void Reducing Asphalt Membrane (VRAM)

This is a relatively new preventive treatment method for longitudinal joints that is applied during paving. MnDOT is currently researching the effectiveness of this treatment. VRAM installation entails spraying a heavy application of an asphalt product with a high pressure distributor truck in an 18” wide longitudinal strip along the longitudinal joint. The product is applied prior to paving the final lift of asphalt. Each paving pass of the final lift should cover half of the applied VRAM such that the final longitudinal joint is centered along the 18” wide strip of VRAM. These products are designed to be activated by the heat from hot mix asphalt placed over the VRAM. Once activated, the VRAM is designed to wick up into the hot asphalt and fill any excess air voids that may be present at the longitudinal joint.

As stated previously, VRAM is currently in the research phase at MnDOT, so its effectiveness on Minnesota highways is unknown. Other state Agencies have had success using VRAM. This section will be updated when more performance data is available for VRAM on Minnesota projects.

VRAM after application. The right lane has had tack applied for paving.

Half of the VRAM has been paved over. In the center of the photo, some of the VRAM has begun migrating upwards into the asphalt mat.

Figure 5.11 VRAM Application

CHAPTER 6 – OTHER PAVEMENT PRESERVATION TECHNIQUES -LOCAL GOVERNMENT FOCUSED

Introduction

This section summarizes other pavement preservation treatments used by local governments. The summaries will be followed by brief descriptions of best construction practices and pictures. The costs in the summaries section are approximate ranges and were gathered from surveying local agencies and vetted during Technical Assistance Panel meetings.

Identifying Feasible Preservation Treatments

As noted in Chapter 3, the treatment strategy for those pavement sections identified as candidates for pavement preservation can be determined by looking at the type and severity of pavement distresses present on the pavement. Guidelines for determining recommended and feasible treatments are provided in Figure 6.00 below.

Pavement Conditions	Severity Level (1)	Rejuvenators	Cape Seal*	Scrub Seal	Slurry Seal
Transverse Cracking	Low				
	Medium				
	High				
Longitudinal Cracking	Low				
	Medium				
	High				
Longitudinal Joint Cracking	Low				
	Medium				
	High				
Multiple Cracking (Block Cracking)	Low				
	Medium				
	High				
Alligator Cracking	Low				
	Medium				
	High				
Rutting	Low				
	Medium				
	High				
Raveling and Weathering (Load Related)	Low				
	Medium				
	High				
Patching (Prior Patching)	Low				
	Medium				
	High				
RQI	3.0-4.0				
	2.0-2.9				
	1.0-1.9				
ADT**	<2,500				
	2,500-10,000				
	>10,0000				
Friction	Poor				

with micromill and overlay
with micromill and overlay

Legend
Recommended
Feasible
Not Recommended

Notes
*These treatments require ADA compliance as part of the project.
**Consider speeds when identifying best treatments
1 - For more information on severity levels, please see the MnDOT Pavement Distress Identification Manual:
http://www.dot.state.mn.us/materials/manuals/pvmtmgmt/Distress_Manual.pdf
Crack Filling to Rut Filling is from:
http://mndot.org/materials/pavementpreservation/manualsandguides/documents/MnDOT_Pavement_Preservation_Manual.pdf

Figure 6.00: Treatment Selection Guidelines for Flexible Pavements

600 –Rejuvenators

(Spray application for pavement preservation, does not include rejuvenators added at plant)

"Rejuvenators are products designed to restore original properties to aged (oxidized) asphalt binders by restoring the original ratio of asphaltenes to maltenes" (Pavement Interactive). Rejuvenators have potential to delay the loss of surface fines and reduce the formation of additional cracks. Rejuvenators are generally appropriate for low-volume, low-speed roads or parking lots.

Many rejuvenators are proprietary, making it difficult to offer a good generic description; rejuvenators can be categorized by their material source/manufacturing process:

Type	Examples of Proprietary Product Names
Asphalt based	CMS-1PF, ReGenX, RejuvaSeal
Maltene based (naphthenic petroleum)	Reclamite
Bio-based	Delta Mist, BioRestor, RePlay

The National Road Research Alliance (NRRA) has recently completed a detailed synthesis on spray on rejuvenators.

Specifications: MnDOT does not have a specification for rejuvenators. Agencies could use 2355 Bituminous Fog Seal modifying for applicable materials (2355.2) and follow manufacturer's recommendations. The NRRA synthesis also includes a section on specifications.

Costs: $0.85-$2.00 per square yard

$5,984-7,040 per lane mile

This does not include mobilization, traffic control, and stripping.

Treatment Description: Since most rejuvenators are proprietary; products are unique to each manufacturer. Most rejuvenator products are low viscosity compared to emulsion fog seals, allowing them to penetrate further into pavement voids. They are typically applied at lower application rates to emulsion application rates. The following table is from NCAT:

Surface Treatment Product	Composition	Product Use by Manufacturer Recommendation	Application Rate (gal/yd²)	Dilution Rate
CMS-1PF	Hybrid emulsion containing polymer-modified asphalt base and rejuvenator	Rejuvenating fog seal, bond coat or cold pour crack filler	0.08	30% residual
ReGenX™	----	Age-regenerating surface treatment	0.07	2:1
RejuvaSeal	Aromatic oils & solvents	Asphalt rejuvenator for revitalizing, sealing and protecting asphalt pavement	0.06	100% residual
Delta Mist™	Plant-based rejuvenator	Topical rejuvenating seal	0.10	30% residual
BioRestor®	Bio-based rejuvenator	Construction seal	0.03	1:1
RePlay™	Polymers and soybean rejuvenator	Surface seals	0.015	100% residual
Reclamite®	Maltene-based from napthenic crude base	Asphalt pavement rejuvenator	0.08	1:1

Figure 6.01: Rejuvenating products used on the NCAT screening study.

Crew: A broom operator to prepare the surface, distributor operator, and traffic control as needed.

Pavement Conditions Addressed: This treatment is applicable for low-severity transverse cracking, low-severity longitudinal cracking, and low-severity raveling/weathering. RQI 3.0 to 4.0. ADT less than 2,500. An asphalt-based rejuvenator may be used on high volume roads with low speeds.

Construction Considerations: As per the NRRA Synthesis, rejuvenators must be applied only when the surface is dry. FAA Specification P632-4.2 states that the rejuvenation product must be applied when the weather forecast is in accordance with the manufacturer's recommendations for application and curing. FPPC Specification states that the surface treatment shall not be applied when the temperature is less than 40˚ in the shade. When applying emulsions, the temperature of the surface shall be a minimum of 59˚F, and no more than 140˚F. Before choosing an application, consider asking the provider about re-application requirements (rates and frequencies).

Treatment Application Recommendations:

- The treatment may be used on higher traffic areas such as rural and urban highways and residential neighborhoods with ADT less than 2,500.
- Low severity cracking, longitudinal and transverse
- No-load related distresses
- RQI greater than 3.0-4.0

Alternatives to Rejuvenators: Fog Seal

Estimated Performance Period:

No research data specifically reporting rejuvenators' performance period.

Local Agencies with Experience:

- City of Eagan
- City of Eden Prairie
- City of Hopkins
- City of Hutchinson
- City of Richfield
- City of St. Anthony
- City of Woodbury
- Beltrami County
- Chippewa County
- Dodge County
- Hennepin County
- Itasca County
- McLeod County
- Otter Tail County

Step 1: Surface is swept clean

Step 2: Rejuvenator is applied to pavement surface; spray application similar to fog seal. Rejuvenators that are not clear will need to be re-striped

Step 3: Some proprietary applications require a screening material applied and swept up 24 hours later

Step 4: Rejuvenators must be allowed to cure (typically 1-2 hours). Note curing includes both to prevent tracking and regain loss of friction from initial application.

Figure 6.02: General Rejuvenator Construction Steps

601 – Cape Seal

A cape seal is used to both seal the road surface from moisture intrusion and improve ride. It is a two-step roadway surface treatment consisting of a chip seal covered by a slurry seal or micro-surfacing treatment. Chip seals are sometimes less desirable by the public because of the rougher pavement surface texture and ride is not improved. With the addition of the top treatment (slurry/micro), the road ends up with a smoother surface.

Primary benefits of a cape seal include sealing of the road surface to prevent moisture intrusion, protecting the pavement from oxidation, preventing raveling, and filling wheel path ruts and cupped cracks. Additionally, cape seals improve ride and skid resistance.

Specifications:

Currently, MnDOT does not have an explicit specification for cape seal. However, there are specifications for:

- Seal Coat layer
  - 2356 Bituminous Seal Coat
    An additional resource is: MnDOT's Seal Coat Design Program and Handbook
- Slurry seal/micro surfacing layer:
  - MnDOT does not have a specification for slurry seals. An alternative source is the Recommended Performance Guideline For Emulsified Asphalt Slurry Seal (please note, these are guidelines, not specifications).
  - 2354 Micro Surfacing

ADA Considerations: Compliance with the Americans with Disabilities Act is required. Therefore, curb ramps will need to be brought to current standards of ADA requirements with the use of this type of treatment.

Costs: $4.60-$5.50 per square yard

$32,384-38,700 per lane mile

$4,628-5,531 per lane mile year

This does not include mobilization, traffic control, and stripping.

Treatment Description: (copied from Road Resource.org)

A cape seal is a process that includes placing a chip seal on the existing pavement surface. Then after a few days, a slurry seal or micro surfacing layer is placed on top of the chip seal.

To place the chip seal, an asphalt distributor provides application of the binder to the pavement surface. A chip spreader immediately applies a uniform, predetermined rate of aggregate onto the binder. These two operations are at the heart of constructing a surface that is one stone thick and has enough asphalt to retain the aggregate, but not an excess amount of binder that causes the surface to bleed. Depending on the binder, aggregate, and actual type of chip seal being constructed, various rollers will be used to orient the aggregate to achieve appropriate embedment. Pneumatic rollers are typically found on all chip seal projects. The rollers are followed by the brooms that remove excess aggregate from the finished surface.

Slurry seal consists of a carefully designed mixture of asphalt emulsion (which may be polymer-modified), mineral aggregate, water and additives; which are proportioned, mixed and uniformly spread over a properly prepared surface at a single stone thickness. Slurry seal is applied as a homogenous mat which adheres firmly to the prepared surface and has a skid-resistant texture throughout its service life. Slurry seal is a quick-traffic system that allows traffic to return shortly (from one to four hours) after placement.

Micro surfacing consists of a carefully designed mixture of polymer-modified asphalt, mineral aggregate, water and additives, proportioned, mixed and uniformly spread over a properly prepared surface which is typically greater than one stone thick. Micro surfacing is applied as a homogenous mat which adheres firmly to the prepared surface and has a skid-resistant texture throughout its service life. Micro surfacing is a quick-traffic system that allows traffic to return shortly (typically less than one hour) after placement.

Crew:

Chip Seal: An emulsion distributor operator, an operator for the chip spreader, 3-4 pneumatic tire roller operators, 3-4 broom operators, trucks as needed to bring aggregate to the project, and traffic control as needed. At the pit there will be a loader operator to load the trucks with chips.

Slurry/Micro surfacing: A broom and operator, 2 people on front of the continuous machine to hook the hose of the emulsion and water trucks to the machine. A slurry/micro surfacing continuous machine driver, a pug mill operator, 2 crew members on the back of the box, 1-2 people on the ground with a lute, 1 person adding the mineral filler at the top of the machine, a distributor truck operator for tack placement. Traffic control as necessary for the job.

Pavement Conditions Addressed: Although cape seals do not add structural capacity, it can provide benefits to pavement distresses including low-severity transverse cracking, low-severity longitudinal cracking, low-severity block cracking, and low and medium-severity raveling/weathering.

Construction Considerations:

For the chip seal, the surface must be clean and dry. Treatment should be placed during warm, dry weather. The chip spreader must be immediately behind the asphalt distributor, with the rollers closely behind the spreader. Pneumatic tire rollers should make a minimum of three passes immediately after chip placement. Typically, seal coats are placed from May 15 to August 10 in the northern part of the state and May 15 to August 31 in the southern portion of the state. The pavement and air temperatures must be 60°F and rising. Construct only in daylight hours. Roads may be damp, but there must be no standing water. Do not construct in rain or foggy weather.

Sweep all pavements the same day as application. Re-sweep the following day to remove all additional loose rock. A cape seal may be used when a slurry or Micro surfacing treatment alone will not address the pavement surface distresses adequately.

For the slurry/micro, the material shall be placed only when the air and pavement surface temperature is above 50°F (10°C) and rising. The weather also may not be foggy or rainy. No material shall be placed when there is a danger that the finishing product will freeze within 48 hours and shall not be placed after September 15.

For micro, a 1,000-foot nighttime test strip is to be completed prior to placement of the micro surfacing, no matter if the treatment is to be constructed in daytime hours. The test strip needs to be able to carry traffic within one hour of placement. Full production may begin after the test strip is approved by the Engineer.

FHWA Construction Inspection Checklist:

The FHWA Cape Seal Pavement Preservation Checklist provides a concise list of important components that go into a successful project.

Treatment Application Recommendations:

- The treatment may be used on higher traffic areas such as rural and urban highways and residential neighborhoods with ADT less than 2,500 to over 10,000.

- Rutting measured in less than 0.10 of one-mile section and is 0.5 inches or less in the left wheel path.
- Not a good crack seal or crack fill candidate (see Figures 4.01 and 4.02); prior to the application, larger cracks and potholes must be addressed.
- Little or no-load related distresses
    - less than 20’ of alligator cracking in 500’ section
    - less than 100’ high severity longitudinal cracking in 500’section
    - less than 10’ high severity transverse cracks in 500’ section (crack spacing of 50’ or more)
    - less than 100’ of multiply cracking in a 500’ section
- RQI greater than 2.0

Alternatives to Cape Seal:

- UTBWC
- Thinlay

Estimated Performance Period: 6 to 8 years.

Step 1. Prepare surface. Surface must be clean. All structures (manholes, valve boxes, etc.) need to be protected prior to placement. Striping may be pre-treated (as shown here) with emulsion. Large pavement messages (turn arrows, RR Xing, etc.) should be removed.

Steps 2 & 3. Emulsion and chip application. The asphalt emulsion is applied to the surface with a distributor truck. Chips are spread from a self-propelled, pneumatic tired unit with a hopper on the front from which the chips are placed onto the roadway

Steps 4 & 5. Rolling and sweeping. After the application of the aggregate, the surface is rolled with pneumatic tired rollers and swept to remove excess aggregate.

Step 6. Prepare surface. Surface must be clean. All structures (manholes, valve boxes, etc.) need to be protected prior to placement.

Step 7. Micro surfacing placement. This photo shows the placement of material using a micro surfacing spreader box.

Figure 6.03: General Cape Seal Construction Steps

602 – Scrub Seal

"A scrub seal is an application that is very similar to a chip seal treatment. The only difference is that the asphalt distributor pulls a broom sled that holds a series of brooms placed at different angles. These brooms guide or "scrub" the emulsion into cracks that ensure the road will be sealed". (Road Resource.org)

A polymer modified rejuvenating emulsion (PMRE) used as a chip binder adds flexibility, toughness, and durability by restoring the asphaltenes and maltenes balance. This allows the process to be used on pavements further down on the deterioration curve where chips seals are normally applied. Scrub seals are similar to chip seal treatments. The main difference is the rejuvenating polymer modified asphalt emulsion is scrubbed into the road surface defects with a series of brooms or squeegees mounted to a trailer.

Specifications:

NRRA has a prototype Scrub Seal Supplemental Specification for agencies to use.

Costs: $1.41-$2.85 per square yard

$9,926-20,064 per lane mile

$1,527 -3,086 per lane mile year

This does not include mobilization, traffic control, and stripping.

Treatment Description: (copied from Road Resource.org)

> A scrub seal is an application that is very similar to a chip seal treatment. The only difference is that the asphalt distributor pulls a broom sled that holds a series of brooms placed at different angles. These brooms guide or "scrub" the emulsion into cracks that ensure the road will be sealed.
>
> The scrub seal is a process by which a unique polymer modified asphalt rejuvenating emulsion is applied to a pavement surface by an asphalt distributor. The emulsion is scrubbed into the cracks and voids with a broom sled before a layer of aggregate is applied over the asphalt. The scrub seal is then rolled with a pneumatic tire roller and is usually ready for controlled traffic in 1 hour or

less. The scrub seal process is intended to rejuvenate dry, oxidized, and cracked asphalt pavements in lieu of a microsurfacing, chip seal or asphalt overlay.

Scrub seals bridge the gap between when chip seals are no longer effective and performing a mill and fill asphalt overlay is too expensive for the current budget. The expectation is that by employing a simultaneous emulsion application and scrub method, one can eliminate mass cracking and improve the quality and durability of more highly distressed pavements.

Crew: A computerized asphalt distributer, variable nozzles, scrub broom sled, aggregate spreader, rollers, sweeping equipment (rotary brooms, pickup sweepers, vacuum sweepers), front end loader, haul truck.

Pavement Conditions Addressed: This treatment is applicable for low and medium-severity transverse cracking, low-severity longitudinal cracking, low-severity block cracking, and low and medium-severity raveling/weathering. RQI 3.0 to 4.0. ADT less than 2,500. Pavements with poor friction.

Construction Considerations:

The surface must be clean. Treatment should be placed during warm, dry weather. Immediately following application of the polymer modified bituminous rejuvenating emulsion binder to the roadway surface, the material shall be scrubbed with the scrub broom for the purpose of forcing the emulsion into the existing surface voids and distributing the emulsion over variable roadway surface textures and conditions. The specified aggregate shall be spread uniformly onto the bituminous binder prior to the emulsion breaking and as agreed to by the Engineer and contractor in the field. Sweeping of the completed surface shall be accomplished prior to unrestricted traffic use. The entire surface shall be clean of all loose material within 24 hours and prior to placement of any surface course.

FHWA Construction Inspection Checklist:

The FHWA Scrub Seal Checklist provides information on the details necessary for a successful project.

Treatment Application Recommendations:

- The treatment may be used on ADT less than 2,500.
- Good treatment for low and medium severity cracks (both transverse and longitudinal).
- Little or no load related distresses
    - less than 20’ of alligator cracking in 500’ section

  - less than 100’ high severity longitudinal cracking in 500’ section
  - less than 10’ high severity transverse cracks in 500’ section (crack spacing of 50’ or more)
  - less than 100’ of multiply cracking in a 500’ section
- RQI greater than 3.0

Alternatives to Scrub Seal:

- Slurry Seal
- Micro surfacing
- Thinlay

Estimated Performance Period: 6 to 7 years (From Road Resource.org)

Local Agencies with Experience:

- City of Duluth
- Carlton County
- Itasca County
- St. Louis County
- Wabasha County (County has developed a specification, contact directly for copy)
- MnDOT District 3 (test sections near Milaca)

Step 1. Prepare/clean surface. All structures (manholes, valve boxes, etc.) need to be protected prior to placement. Striping may be pre-treated with emulsion.

Step 2 The asphalt emulsion is applied to the surface with a distributor that pulls a sled that houses a series of brooms placed at different angles. These brooms guide or "scrub" the emulsion into cracks.

Broom sled

Step 3. Chips are spread from a self-propelled, pneumatic tired unit onto the roadway.

Step 4-5. Rolling and sweeping. After the application of the aggregate, the surface is rolled with pneumatic tired rollers and swept to remove excess aggregate.

Figure 6.04: General Scrub Seal Construction Steps

603 – Slurry Seal

Slurry seals are surface treatments effective at correcting or inhibiting raveling and oxidation of the pavement surface, improving surface friction, sealing the pavement surface, and filling minor surface irregularities and wheel ruts.

A slurry seal is very similar to micro surfacing; the main difference is that slurry seals **do not** contain an additive that causes the chemical "breaking" action. Also, slurry seals cure through a thermal process resulting in longer cure times.

Specifications:

Currently, MnDOT does not have a specification for slurry seals. An alternative source is the Recommended Performance Guideline For Emulsified Asphalt Slurry Seal (please note, these are guideline, not specifications). Additionally, the National Center for Pavement Preservation has a generic specification.

Costs: $2.50-$3.50 per square yard

$17,600 – 24,640 per lane mile

$2,933-4,106 per lane mile year

This does not include mobilization, traffic control, and stripping.

Treatment Description: (Summarized from Road Resource.org)

Slurry seal consists of a carefully designed mixture of asphalt emulsion (which may be polymer-modified), mineral aggregate, water and additives; proportioned, mixed and uniformly spread over a properly prepared surface at a single stone thickness. Slurry seal is applied as a homogenous mat, which adheres firmly to the prepared surface and has a skid- resistant texture throughout its service life. Slurry seal is a quick-traffic system that allows traffic to return shortly (from one to four hours) after placement.

The treatment is favorable due to the reasonable application times and disruption to traffic and does not produce loose chips, therefore, eliminating the risk of potential vehicle damage.

Crew: A broom and operator, 2 people on front of the continuous paving machine to hook the hose of the emulsion and water trucks to the machine, a slurry seal continuous machine driver, a pug mill operator, 2 crew members on the back of the box, 1-2 people on the ground with a lute, a distributor truck operator for tack placement, and traffic control as necessary for the job.

At the pit you will see a loader operator placing aggregate in as many trucks as needed to keep the operation moving and a crew member filling the emulsion truck.

Pavement Conditions Addressed: Slurry seals do not add structural capacity but may provide protection against surface distresses like low severity cracking, raveling/weathering (loose material must be removed), minor roughness, friction loss, and moisture infiltration. Slurry seals will also temporarily seal cracks (if severity is low) and can serve as a rut-filler (if the existing ruts are stable). Prior to treatment placement, it may be necessary to perform other treatments to address other issues, such as rut filling, patching, or crack treating.

This treatment is applicable for low-severity transverse cracking, low-severity longitudinal cracking, low-severity block cracking, and low and medium-severity raveling/weathering. RQI 3.0 to 4.0. ADT less than 2,500. Pavements with poor friction.

Construction Considerations: Slurry seals should be placed only when the air and pavement surface temperature is above 50°F (10°C) and rising. The weather also should not be foggy or rainy. No slurry seals shall be placed when there is a danger that the finished product will freeze within 48 hours. Should not be placed after September 15.

FHWA Construction Inspection Checklist:

The FHWA Slurry Seal Checklist provides a list of key components that are necessary for a successful project. is a collection of inspection checklists for different pavement preservation treatments. They are designed to help guide an Inspector or Project Engineer in the field.

Treatment Application Recommendations:

- Traffic less than 2,500 ADT
- 7 or more years since last rehabilitation and last rehabilitation not a surface treatment
- Rutting measured is less than 10% of mile section and is 0.5 inches or less in the left wheel path
- Not a good crack seal or crack fill candidate (see Figures 4.01 and 4.02)
- Little or no load related distresses
    - less than 20’ of alligator cracking in 500 feet section

- less than 100’ high severity longitudinal cracking in 500’
- less than 10 high severity transverse cracks in 500 feet (crack spacing of 50’ or more)
- less than 100’ of multiply cracking in a 500’ section

- RQI greater than 3.0

Alternatives to Slurry Seal:

- Sealcoat
- Scrub Seal
- Microsurfacing
- Thin Overlay

Estimated Performance Period: 5 to 7 years

Local Agencies with Experience:

- City of Duluth
- City of Eagan
- City of Hastings
- City of Monticello
- Olmsted County

Step 1. Prepare surface. Surface must be clean. All structures (manholes, valve boxes, etc.) need to be protected prior to placement.

Step 2. Slurry seal placement. This photo shows the placement of material using spreader box.

Figure 6.05: General Slurry Seal Construction Steps

INDEX

REFERENCES

1. South Dakota Department of Transportation, *Pavement Preservation Guidelines,* 2010

2. Illinois Bureau of Local Roads and Streets Manual – Chapter 52 PAVEMENT PRESERVATION, 2010

3. Peshkin, D. G., T. E. Hoerner, K. D. Smith, J. E. Bruinsma, and S. B. Seeds, FHWA-NHI-04-171 *Pavement Preservation: Design and Construction of Quality Preventive Maintenance Treatments*, NHI Course 131103, Reference Manual, National Highway Institute, Federal Highway Administration, Washington, DC., 2004.

4. Haas, R., W. R. Hudson, and J. Zaniewski. *Modern Pavement Management.* Krieger Publishing Company. Malabar, FL, 1994

5. Federal Highway Administration, "Chapter 3. Pavement Treatment Types." *Evaluation of Pavement Safety Performance*, 2015

6. Federal Highway Administration, *Pavement Preservation Checklist Series*, 2002

7. "Micro-Milling – The Finer Side of Milling" 20 September 2011. http://www.pavementinteractive.org <http://www.pavementinteractive.org/2011/09/20/micro-milling-the-finer-side-of-milling/> Accessed 24 August 2017

8. Wood, T. J. *Longitudinal Construction Joint Repair on I-494*. Maplewood, MN: Minnesota Department of Transportation, 2007

9. Dailey J, Dave E, Barman M, Kostick R *Comprehensive Field Evaluation of Asphalt Patching Methods and Development of Simple Decision Trees and a Best Practices Manual*. Report Number MN/RC 2017-25. St. Paul, MN: Minnesota Department of Transportation, 2017

10. Minnesota Department of Transportation, *MnDOT Bituminous Manual,* 2019

11. "Rejuvenators" https://pavementinteractive.org/ <https://pavementinteractive.org/reference-desk/maintenance-and-rehabilitation/maintenance/rejuvenators/> Accessed 10 January 2020

12. National Road Research Alliance, *Spray Rejuvenators Synthesis*, October 2019. http://dot.state.mn.us/mnroad/nrra/structure-teams/preventive-maintenance/documents/nrra-spray-on-rejuvenator-synthesis-final.pdf Accessed 10 January 2020

13. Minnesota Department of Transportation, *Standard Specifications for Considerations,* 2018. http://www.dot.state.mn.us/pre-letting/spec/index.html Accessed 10 January 2020

14. National Center for Asphalt Technology. "Evaluation of Rejuvenating Fog Seals," *Asphalt Technology News*, Vol 31 Num 1, Spring 2019. http://eng.auburn.edu/research/centers/ncat/info-pubs/newsletters/newsspring19.pdf Accessed 10 January 2020

15. Minnesota Department of Transportation, *Seal Coat Design Program and Handbook,* 2006. http://www.dot.state.mn.us/materials/researchsealcoat.html Accessed 10 January 2020

16. International Slurry Surfacing Association, *Recommended Performance Guideline for Emulsified Asphalt Slurry Seal*, February 2010. https://cpmamerica.com/wp-content/uploads/2013/08/Slurry-guidelines-from-ISSA.pdf Accessed 10 January 2020

17. Federal Highway Administration, "Americans with Disabilities Act (ADA) Requirements for Resurfacing Projects." *Federal-aid Essentials for Local Public Agencies.* https://www.fhwa.dot.gov/federal-aidessentials/catmod.cfm?id=107 Accessed 10 January 2020

18. *Pavement Preservation Treatments*, 2018. https://roadresource.org/treatment_resources Accessed 10 January 2020

19. Federal Highway Administration, "Cape Seal." *Pavement Preservation Checklist Series*, July 2019. https://www.fhwa.dot.gov/pavement/preservation/2019checklists/hif19043.pdf Accessed 10 January 2020

20. National Road Research Alliance, *Polymer Scrub Seal Supplemental Specification*, 18 July 2016. http://dot.state.mn.us/mnroad/nrra/structure-teams/preventive-maintenance/documents/Polymer%20SCRUB%20SEAL%20Supplemental%20Specification%207-18-2016.pdf. Accessed 10 January 2020

21. Federal Highway Administration, "Scrub Seal." *Pavement Preservation Checklist Series,* July 2019. https://www.fhwa.dot.gov/pavement/preservation/2019checklists/hif19040.pdf Accessed 10 January 2020

22. National Center for Pavement Preservation, *Slurry Seal Surfacing,* 15 September 2014. https://www.pavementpreservation.org/wp-content/uploads/2017/03/FPPC335_Slurry_Seal_Surfacing.pdf Accessed 10 January 2020

23. Federal Highway Administration, "Slurry Seal." *Pavement Preservation Checklist Series,* July 2019. https://www.fhwa.dot.gov/pavement/preservation/2019checklists/hif19036.pdf Accessed 10 January 2020

24. Minnesota Department of Transportation, *Guidance on Thinlay as a Pavement Preservation Technique,* 10 August 2016. http://www.dot.state.mn.us/stateaid/projectdelivery/pdp/pavement/thinlay-design-guidance.pdf Accessed 10 January 2020

25. Minnesota Department of Transportation, *2360 Thinlay Asphalt Mixture*, 10 August 2016. https://www.dot.state.mn.us/stateaid/projectdelivery/pdp/pavement/thinlay-2360-special-provision-2016.pdf Accessed 10 January 2020

26. Minnesota Department of Transportation, *3139 Graded Aggregate for Thinlay Asphalt Mixture,* 10 August 2016. https://www.dot.state.mn.us/stateaid/projectdelivery/pdp/pavement/thinlay-3139-special-provision-2016.pdf Accessed 10 January 2020

27. Federal Highway Administration, *"*Thin Hot Mix Asphalt Overlay." *Pavement Preservation Checklist Series*, July 2019. https://www.fhwa.dot.gov/pavement/preservation/2019checklists/hif19030.pdf Accessed 10 January 2020