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Asphalt Pavement Maintenance

Field Handbook

Handbook



UNIVERSITY OF MINNESOTA
CENTER FOR TRANSPORTATION STUDIES
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MINNESOTA DEPARTMENT
OF TRANSPORTATION
(Mn/DOT)



MINNESOTA LOCAL ROAD
RESEARCH BOARD



FEDERAL HIGHWAY
ADMINISTRATION

Asphalt Pavement Maintenance Field Handbook

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INTRODUCTION

HOW TO USE THIS MANUAL

This field manual provides guidelines for preventive asphalt pavement maintenance techniques for a variety of distresses and conditions. It covers:

- crack treatments (clean and seal, rout and seal, full-depth crack repair)
- surface treatments (fog seal, seal coat, thin hot-mix overlays)
- pothole patching and repair (cold-mix asphalt, spray injection patching, hot-mix asphalt, slurry or microsurfacing material)

RELATED PUBLICATIONS

This field manual is condensed from the *Best Practices Handbook on Asphalt Pavement Maintenance*, manual number 2000-04, available from Mn/DOT's Office of Research Services at 612-282-2274.

The Minnesota Local Road Research Board (LRRB) developed a set of pavement distress manuals that identify low-, medium- and high-severity levels of each pavement distress with photos. Causes for the pavement distress types are also given, and distresses are categorized by their cause: environmental, traffic, or construction. Two field manuals are available: the *Flexible Pavement Distress Manual* and the *Rigid Pavement Distress Manual*. Also available is an accompanying report, No. 89-01, *Pavement Rehabilitation: A Guide for Minnesota Cities and Counties*. Contact the Mn/DOT Office of Research Services at 651-282-2274 to order.

CRACK TREATMENTS

Table 1. Recommended Applications for Crack Sealant and Fillers

Material	Mn/DOT Spec.	Recommended Application
Low Modulus Extra Low Modulus	3720 3725	<ul style="list-style-type: none"> • Crack sealer – A lower modulus sealant with a 3/4-inch x 3/4-inch reservoir size and less overband is very effective for rout and seal. • Mn/DOT specification 3725, which is softer at low temperatures than 3720, is now the recommended sealant for rout and seal. It is also the recommended sealant for saw and seal.
Rubberized Asphalt	3723	<ul style="list-style-type: none"> • Crack filler/crack sealer – This product exhibits good adhesion qualities, and has been the common sealer for rout and seal until recently. It can be used for rout and seal in situations where wider reservoir widths are needed, and also for the clean-and-seal (formerly known as blow-and-go) method.
Crumb Rubber	3719	<ul style="list-style-type: none"> • Crack filler – Crumb rubber is very effective with the clean-and-seal method. This process works best in the early spring or late fall when the cracks are open. Crumb rubber will crack in the winter but re-heal during warmer weather. A double jacket melter is needed to maintain proper temperature of the product during application.
Asphalt Emulsion	CSS-1 CSS-1H CRS-2P HFMS-2	<ul style="list-style-type: none"> • Crack filler – Asphalt emulsion can be used as a crack filler, primarily to coat the crack edges and fill some of the crack. • Quantities will shrink with curing. Emulsions are safe and easy to use but limited to use in warmer seasons.
Asphalt Cement	AC-3	<ul style="list-style-type: none"> • Crack filler – AC-3 is an air-blown asphalt that can be used to coat the edges and fill crack. This product will get quite brittle in the winter and may track in warmer weather.
Cutback Asphalt	RC MC SC	<ul style="list-style-type: none"> • Crack filler – Cutback asphalt, like emulsions, can be used primarily to coat the edges of cracks. They are not as readily available or safe as emulsions but can be used in the winter months.

Table 2. Effective Sealing Tips

Technique	Tip
Saw and Seal	<ul style="list-style-type: none">• Place the sealant flush to the pavement surface. The strike-off will create a "slight overband" that helps the sealant adhere better to the pavement surface/reservoir edge corner.
Rout and Seal	<ul style="list-style-type: none">• Make the total width of the overband about 2-1/2 inch (3/4-inch rout plus 3/4-inch overband on each side of the reservoir). The overband should be as thin as possible.
Clean and Seal <i>(formerly "blow and go")</i>	<ul style="list-style-type: none">• Clean and dry the crack before placing sealant.• Perform in late fall or early spring when cracks are open.• Take care not to burn pavement with hot-air lance. Follow manufacturer's recommendations for sealant application temperatures.

Bumps in overlays do not have to happen. Perform crack sealing 6 to 12 months prior to an overlay. Proper sealant application procedures and roller operation techniques can eliminate bumps caused by too much sealant or roller slippage.

CRACK TREATMENT: Clean and Seal (formerly "Blow and Go")

Clean and seal, used on all types of cracks, involves blowing out crack debris using a hot-air lance or compressed air and then filling with a sealant.

- Perform when temperatures are moderately cool, as in spring and fall.
- Reroute traffic until the sealant material cures. If the roadway must be

opened immediately after sealing, protect the sealant against pick-up by tires by lightly covering the sealant material with fine sand or toilet paper.

- Note that moisture will prevent bonding of the crack sealer to the crack walls.



1 Dry thoroughly with hot-air lance or high-pressure air hose.



2 Fill clean crack with sealant.



3 Strike off sealant with squeegee to create overband.

CRACK TREATMENT: Rout and Seal

Rout and seal, used on transverse and longitudinal cracks, involves using a pavement saw or router to create a reservoir centered over existing cracks, then filling with a sealant.

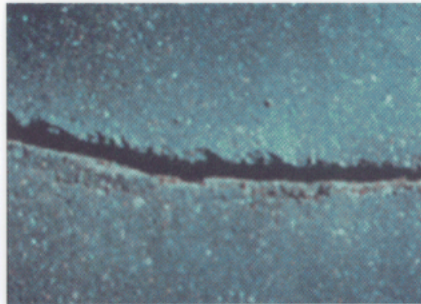
- Mn/DOT's standard specification calls for a 3/4-inch by 3/4-inch reservoir, but you may adjust the size depending on the sealant. Level the sealant with a 3/4-inch overband. Make a second pass with additional filler.
- Placing an overband is acceptable; however, consider motorcycle traffic.

When longitudinal cracks are sealed, especially on curves, tires may slip when traveling over the overband material. This can be very dangerous and should be avoided when sealing longitudinal cracks on curves.

- Apply when temperatures are moderately cool, as in spring and fall.
- Reroute traffic until the sealant material cures. If the roadway must be opened immediately after sealing, protect the sealant against pick-up by tires by lightly covering the sealant material with fine sand or toilet paper.



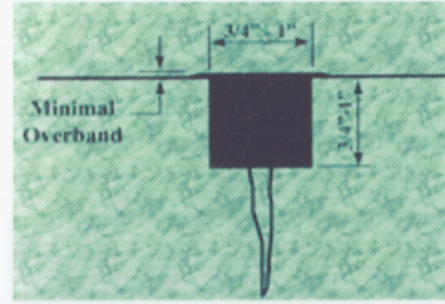
1 Rout cracks.



2 Remove debris before placing sealant.



3 Place sealant meeting Mn/DOT spec. 3725.



4 3/4-inch x 3/4-inch reservoir

CRACK TREATMENT: Full-Depth Crack Repair

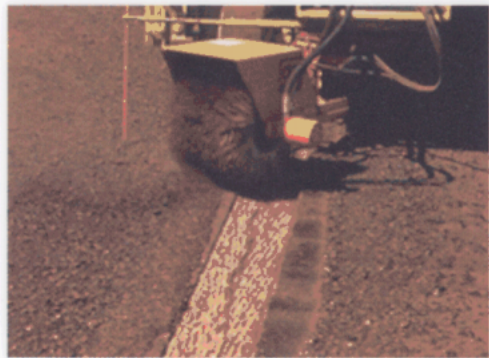
Full-depth crack repair involves milling a trench centered over an existing crack, placing hot-mix asphalt (HMA) into the reservoir in one or more lifts, and compacting to achieve density.

- Milling depth varies from 1/2 inch for cracks in good condition, to full depth for pavements with severe deterioration in the crack vicinity. The mill width varies from 10 to 12 inches for shallow milling to 3 to 4 inches for deep milling. When choosing the configuration of the area to be milled, the trench should be wide enough to ensure good compaction. It is difficult to achieve good compaction in a deep and narrow trench.
- Release traffic after mixture has been compacted and cured.
- Properly drain cracks that have been milled and cleaned out if they are allowed to stand before new asphalt course is placed.

Workmanship and density is very important.

Sequence:

1. Mill out the crack.
2. If needed, use a skid loader to remove millings from the roadway.
3. Vacuum out the reservoir.
4. Tack the reservoir with asphalt emulsion.
5. Place hot mix into the reservoir in lifts < 4 inches.
6. Compact the reservoir with roller so that patch is flush with adjacent pavement.



1 Mill and sweep crack to remove any loose material.



2 A clean reservoir ready for new hot mix



3 Place hot mix neatly in reservoir.



4 Compact the hot mix with roller so that patch is flush with adjacent pavement.

SURFACE TREATMENTS

Table 3. Recommended Applications for Surface Treatments

Material	Mn/DOT Spec.	Recommended Application
Fog Seal	2355	<ul style="list-style-type: none"> • CSS-1 or CSS-1h diluted with an equal amount of water usually applied at 0.05 to 0.15 gal/sy. A spraying temperature of 125 to 160°F and surface temperature of at least 50°F and rising are recommended.
Seal Coat	2356	<ul style="list-style-type: none"> • Use only on a clean pavement surface. • Use the design application rates for binder and aggregates. • Use high-quality materials. • Minimize the distance between the distributor and the spreader. Place aggregate before emulsion starts to break. • Use at least three rollers, all at maximum speed of 5 mph. Complete compaction before emulsion breaks. • Sweep the roadway as soon as possible, and no later than the next morning.
Slurry Seal	ISSA Spec.	<ul style="list-style-type: none"> • Pavement should be dry and clean, and all necessary repairs or reconditioning work completed first. • Place when both the air and pavement temperature are at least 50°F and there is no chance of freezing within 24 hours after placement. Do not place during rain.
Micro-surfacing	Special Provision	<ul style="list-style-type: none"> • Follow mix design carefully. • Ideal for high-volume roads. • Pavement should be clean, and all necessary repairs or reconditioning work completed first.
Thin Hot-Mix Overlay	2350	<ul style="list-style-type: none"> • Use a quality mix. • Density is vital to performance. • Sand mixes (aggregate size 3/8-inch minus) are not recommended. • Place with paver, not blade. • Ideal for high-volume roads.

SURFACE TREATMENT: Fog Seal

A **fog seal** is an application of diluted asphalt emulsion without a cover aggregate, used to seal and enrich the asphalt pavement surface, seal minor cracks, prevent raveling, and provide shoulder delineation.

- Pavement should be dry and clean, and all necessary repairs or reconditioning work should be completed prior to placing the fog seal. Place sealer with an asphalt distributor.
- The application rate is key. Emulsion rates usually range from 0.05 to 0.15 gal/sy. Keep the application rate low to prevent splashing and decreased skid resistance. A spraying temperature of 125 to 160°F and surface temperature of at least 50°F and rising are recommended.
- Apply when temperatures are warm or hot. Cool temperatures require longer curing times prior to opening the roadway to traffic.
- Keep traffic off the emulsion until it has cured. Sand cover may also be used to improve the surface friction.

- Use asphalt emulsion diluted with an equal amount of water (such as CSS-1, CSS-1H) or proprietary rejuvenator meeting Mn/DOT specification 3151.
- Don't over-apply the binder.
- Use CSS-1 or -1h, which will allow the emulsion to penetrate the existing pavement surface before curing.



Pavement should be dry and clean before fog sealing.

SURFACE TREATMENT: Seal Coat

A **seal coat** is an application of asphalt emulsion followed immediately with an aggregate cover. The *Seal Coat Handbook*, Mn/DOT document number 1999-07, provides very detailed information about seal coat design and placement.

- Use only on clean pavement surface.
- Use high-quality materials.
- Use the proper binder application rate.
- Use the correct aggregate application rate, which will result in a single layer of chips embedded approximately 70 percent into the binder with little or no excess chips to remove.
- Minimize the distance between the distributor and the spreader. Place aggregate before the emulsion starts to break.
- Calibrate equipment to ensure the application rates are correct. See the *Seal Coat Handbook* for directions.
- On the distributor, adjust the nozzle angle in relation to the spray bar. The

recommended angle is between 15 and 30 degrees.

- Use a minimum of three rollers, all at a 5 mph maximum speed. Complete rolling before emulsion breaks.
- Sweep the roadway as soon as possible, and no later than the next morning.
- Ideal placement conditions are a warm, sunny day with low humidity. Never seal coat when showers are threatening.

Conduct seal coating operations (including traffic restrictions on the freshly constructed seal coat) after May 15 and before August 31, only during daylight hours, when the pavement and air temperature are 60°F or higher, and when the relative humidity is less than 75 percent. In addition, do not perform seal coat operations in foggy or rainy weather. Seal coating requires a minimum of two weeks with weather above freezing.

Seal Coat *continued*

Do not permit traffic on the sealed road surface until after all rolling has been completed and the bituminous material has set and will not pick up on vehicle tires.

Sequence:

1. Sweep the existing surface to clean and remove loose debris.
2. Apply the asphalt binder with a distributor.



1 Minimize the distance between the binder distributor and aggregate spreader.

3. Apply cover aggregate using a self-propelled chip spreader.
4. Roll the chip-sealed surface with pneumatic-tired rollers. Three passes should be the goal.
5. Sweep excess chips as soon as possible without damaging the sealed surface. This normally can be done the next day, sooner if modified binders are used.



2 Use a minimum of three rollers, all at 5 mph maximum speed.

SURFACE TREATMENT: Thin Hot-Mix Overlays

Dense-graded **hot-mix overlays** are used to improve the functional (non-structural) condition of the pavement. Thicknesses are less than 2 inches.

- Milling or placing a leveling course should precede thin HMAs where pavements need cross-section improvements. In addition, all cracks should be sealed prior to application. Tack coats are necessary when using thin HMAs.
- Maximum aggregate size is half the lift thickness. Aggregate one-third times the lift thickness is preferred.
- Mixes should be placed in warm weather (55°F minimum) and must be rolled immediately. Due to their low mass they lose heat very quickly, and achieving density is only possible if they are compacted while still hot.

- Specification 2350 is recommended and should be placed with a paver. Compaction is important to performance. "Sand mixes" (those made with 3/8-inch minus aggregate) are not recommended.



Specification 2350 is the recommended mixture. Place with a paver.

POTHOLE AND PATCHING REPAIR

This section includes information on both permanent and temporary patching. For both types of repair:

- Use high-quality patching material.
- Compact every patch, even by driving over the patch with a truck.
- **Place material into the patch area**—don't throw it in.

For full-depth permanent patching, remove the material in the failed area and replace it with fresh asphalt mixture.

1. Mark the area to be patched, extending at least 1 foot outside the distressed area. The outline should be rectangular with two sides at right angles to the direction of traffic. Cut the outline of the patch with a saw.
2. Remove as much pavement as necessary to reach firm support, using a milling machine, backhoe, or front-end loader. For alligator cracking and potholes, remove weak granular base and subgrade materials before replacing the asphalt surface course. Cut faces should be straight, vertical, and solid. Trim and compact the granular base or subgrade to establish a firm foundation. Apply tack to the vertical edges of the excavated area, and a prime or tack coat to the base of the excavation.

3. Backfill the excavation with asphalt mixture. Shovel the patching mixture directly from the truck, and place the mix against the edges first. Spread the mix carefully to avoid segregation. Avoid pulling material from the center of the patch to the edges. After compaction, the patch surface should be flush with the adjacent pavement, not humped or depressed.

Table 4. Recommended Applications for Patching

Material	Mn/DOT Spec.	Recommended Application
Cold Mix	2381	<ul style="list-style-type: none"> • Cold mix is normally used during winter months. It is important to use high-quality material and to compact properly. • Emulsions are recommended for safety and environmental reasons.
Spray Injection	None	<ul style="list-style-type: none"> • This process is best suited for transverse crack repair and pothole filling. Fairly high production, but operator dependent. • Since asphalt emulsion is compatible with water, the crack does not need to be perfectly dry to obtain long patch life.
Hot Mix	2350 LV Type 5	<ul style="list-style-type: none"> • Clean the reservoir. Perform in good weather, with pavement temperatures greater than 50°F. • Compaction is essential for every patch, even if you drive over the patch with a truck to do it. • Place material in the patch area—don't throw it in.
Slurry and Microsurfacing Material	None	<ul style="list-style-type: none"> • Based on availability of equipment to be used for transverse crack leveling. This process is a high-production operation that should create a level surface. Microsurfacing gives a more durable patch but is more sensitive to placement activities. • Because of the required cure period, do not use slurry to fill deep cracks or cracks that have developed large potholes.

Table 5. Effective Patching Tips

Technique	Tip
All	<ul style="list-style-type: none">• Quality control and density are very important to obtaining good performance.• Use high-quality patching materials, which are cost-effective compared with less expensive products. Lower cost materials will cost more because they don't last.
Hot Mix	<ul style="list-style-type: none">• Use high-quality mix on permanent patches.
Cold Mix	<ul style="list-style-type: none">• When using cold mix in heated hoppers, watch temperatures. Do not heat material over 100°F. When heated to higher temperatures, binder may harden.• Use year-round for temporary patches.

Cold-mix asphalt, sometimes called stockpile patching mixture, consists of a plant-mixed material made of a suitable binder, a compatible aggregate, and an additive for moisture resistance.

- Use a high-quality material. Several proprietary mixes are available as well as Mn/DOT standard specification 2381. These high-quality mixtures consist of a 100 percent crushed aggregate with low percentage (3 percent) passing the #200 sieve and a maximum size of 3/8 inch. This formulation allows for a higher binder content, which is necessary for a thicker asphalt film to ensure durability. It also results in a self-tacking material. The crushed particles are required for better stability.
- Binders for cold mix consist of both cutback and emulsified asphalts.

- Pothole patching mixtures are subjected to extensive, vigorous water action. Therefore, stripping is a major concern. Anti-strip additives are necessary to increase resistance to stripping.
- Even high-quality materials require densification to obtain good performance. Rolling the repair with the truck tire will aid in compaction.

Do not overheat this material to above 100°F, because it will stiffen the mix prematurely. Cold-mix material can be used year-round, since hot mix can cool during the day and become difficult to handle and compact. Some proprietary mixes have special summer formulations.

POTHOLE AND PATCHING REPAIR: Spray Injection Patching

Spray injection patching, also referred to as blow patching, uses air pressure to apply asphalt emulsion and aggregate into large cracks and potholes.



1 *Spray injection crack repair*



2 *Spray injection patching used on a pothole*

- Minimize oil use.
- A skilled operator is required for a quality patch.
- Allow traffic over the repaired areas as soon as maintenance workers and equipment are clear.

The spray-injection procedure consists of the following steps:

1. Blow water and debris from the pothole.
2. Spray a tack coat on the sides and bottom of the pothole.
3. Blow asphalt and aggregate into the pothole.
4. Cover the patched area with a layer of aggregate.

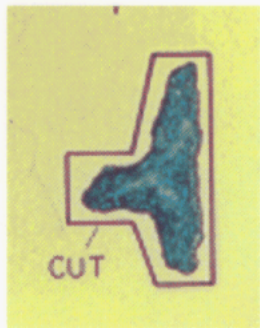


3 *Spray injector*

POTHOLE AND PATCHING REPAIR: Hot-Mix Asphalt

Hot-mix asphalt is a plant-mixed mixture of aggregate and asphalt cement.

- Material may not be available at all times of the year.
 - Traffic may be allowed over the repaired areas as soon as the patch has cooled sufficiently and is not displaced by weight of vehicles.
- Hot-mix asphalt patches typically last from three to six years.
 - This work is limited by the availability of hot-mix asphalt to complete the patching.



1 Mark area to be patched, extending at least 1 foot outside the distressed area.



2 Remove as much pavement as needed to reach firm support.



3 Place patching material in hole and compact.

POTHOLE AND PATCHING REPAIR: Slurry or Microsurfacing Material

Slurry or microsurfacing crack filling involves placing a slurry—which is a mixture of aggregate, asphalt emulsion, and a mineral filler such as Portland cement—into a wide crack and striking it off with a squeegee. Slurry-filling cracks is good for roadways with severe transverse cracks and/or depressed transverse cracks. A 3-foot-wide squeegee, with sideboards, is typically used to feather the material into the depressed areas.

Aggregates for slurry mixes may consist of most hard-crushed aggregates such as granite, limestone, trap rock, slag, and taconite tailings. They conform to one of three gradations: Mn/DOT 3139 Type 1, Type 2, and Type 3. The maximum size for slurry aggregates is 2.36 mm (#8 sieve) for Type 1, and 9.5 mm (3/8-inch sieve) for Type 2 and 3. Type 3 has a coarser gradation than Type 2. All slurry gradations have between 5 and 15 percent passing the 75-micron sieve (#200).

- Crack preparation should include milling and blowing loose material from the cracks. The cure rate ranges from 30 minutes to 1 hour, depending on the air temperature, humidity, and materials used.
- Because of the required cure period, do not use slurry to fill deep cracks

or cracks that have developed large potholes.

- Avoid late season application.
- Allow material to cure before permitting traffic back on the roadway.
- Rut filling is only successful if the rut was caused by mechanical compaction of the pavement. Filling ruts caused by an unstable pavement layer or structurally deficient pavement is not appropriate.

Guidelines for use of microsurfacing to fill ruts include:

- | | |
|-------------------------------|--|
| Ruts 1/4 to 3/4 inch deep: | Use full-width scratch coat application to level the surface before the final surface is placed. |
| Ruts greater than 3/4 inch: | Use a rut-filling spreader box to fill the ruts before placing the final surface. |
| Ruts greater than 1-1/2 inch: | Fill ruts in multiple placements using the rut-filling spreader box. |
- The maximum thickness applied in a single lift should be less than 1-1/2 inch.

Slurry or Microsurfacing Material *continued*

The construction sequence is:

1. Mill and blow out existing depressions, if desired.
2. Position slurry unit over the crack or depression to be filled.
3. Deposit sufficient amount of slurry material at the transverse center of the crack.
4. Strike off the material with a squeegee or lute rake to fill depressions.



1 Deposit sufficient slurry to fill crack.



2 Strike off slurry material.



3 Completed repair

