Ch 7. Selecting the treatment

Often there is not a clear best choice for a TMS treatment. Each TMS has advantages and disadvantages, depending on a pavement’s distresses. This can make the decision process difficult.

Multiple factors will influence the final decision of the surface to be used:
- Type of distress
- Aesthetics
- Initial cost
- Life cycle costs
- Availability of materials

Type of distress
Certain treatments are better for some distresses than others. For example, if the surface is cracked, a more flexible treatment such as a seal coat is most effective, since it can reduce water intrusion into cracks to a greater extent than a stiffer treatment such as slurry seal or micro-surfacing. However, for rut filling, stiffer treatments such as slurry seal or micro-surfacing are more effective. Therefore, the treatment must be selected to match the distress.

Aesthetics
The appearance of the road will be important to neighboring property owners, some road users, and many others in the community. Consider preferences in aggregate color and texture that stakeholders may have.

Initial costs
Most maintenance programs have to fit within an annual budget. If a certain amount of road must be maintained, this may limit the choices available to the decision maker.

Life cycle costs
Decisions about maintenance investments can have impacts on future maintenance and construction costs. It may be possible to delay a construction project and invest the funding in maintenance, thereby delaying the need for future rehabilitation and construction. On the other hand, a well-selected reconstruction or rehabilitation project might reduce future maintenance costs. Decision makers should consider how their decisions will affect the costs for the entire life cycle of the road.

Availability of materials
Transportation of aggregates is very expensive in comparison to their value in a stockpile at the quarry. For this reason, decision makers often decide to limit their choices to locally available aggregates. Rail or barge transportation may provide opportunities to ship aggregates longer distances. In addition, asphalt suppliers provide a limited number of emulsions and, like aggregate, the cost of transportation is high in comparison to the value of the product. So, as with aggregates, decision makers will be limited in the variety of emulsions and other binders that they can specify.

Availability of contractors and equipment
Mobilization costs can be high and scheduling can be difficult for contractors who are not local to the area. Therefore, decision makers may decide to use treatments that can be applied by local contractors. If the work is performed by a government agency using their own workers and equipment, decision makers may be limited to methods and materials that can be applied using those resources.

Repetition and economics of scale
Many jurisdictions settle on a limited number of treatments that work well for them, then repeat those treatments on a regular basis (e.g., once every one to five years). Mobilizing to provide a small amount of a particular treatment that is not one of those regularly used may be uneconomical or administratively challenging. Therefore, decision makers will often rely on treatments that are in their usual repertoire as much as possible. However, by being in the habit of using a particular treatment, decision makers run the risk of misapplying that treatment or not realizing that it might be economical to use a different treatment.
Common HMA pavement conditions

The examples in this section illustrate common HMA pavement conditions and suggest possible thin maintenance surface selections. See Figure 1.

HMA No. 1: Excellent to very good condition

- Pavement is slightly to moderately oxidized and is beginning to pock or ravel in low severity.
- Thermal cracks have formed but are still thin (hairline to ¼ inch), or joints cracks from underlying pavement have reflected and are of low severity.
- There is no indication of structural failure.

In this example, because there is little distress, all thin maintenance surfaces could be considered for preventive maintenance. However, from the perspective of road users, thin maintenance surfaces other than fog seal may result in a rougher road texture that would be considered undesirable. Nevertheless, the benefits of arresting oxidation and waterproofing the surface may extend pavement life sufficiently to justify an investment in maintenance. Many of these benefits can also be obtained with a fog seal.

Preconstruction

Cracks should be sealed two to three months before construction.

Surfaces suitable for this pavement

Fog seal—Recommended if the distresses are of low severity.

Fog seal is effective for waterproofing the surface of the pavement, mitigating raveling, and sealing thin cracks. Fog seal also restores a dark color that resembles a new asphalt pavement and is a good background for pavement markings.

Note: A fog seal will reduce friction until the binder has been worn off the tops of the exposed aggregate. Applying sand can help to restore the friction. Also, the road will have to be closed until the emulsion has cured, which can take up to eight hours, depending on the weather.

Slurry seal, micro-surfacing—Recommended if pavement is moderately oxidized or pocked. Effective at sealing all of the distresses described in this exam-

ple and provides a new high-friction wearing course.

Slurry seals can be used in place of a seal coat with little added cost. The slurry seal has the advantage of a higher aesthetic value over the seal coat. Also, if the pavement has low-severity and low-density cracking, the slurry seal will perform well.

Compared to a slurry seal, micro-surfacing may have a longer service life, but the cost of micro-surfacing is higher than that of a slurry seal.

Seal coat—Recommended with caution. Although seal coat will likely extend pavement life, it may have limited acceptance by road users, neighboring property owners, and other stakeholders. High-quality application techniques, smaller aggregate, and premium materials are recommended if seal coat is applied to a pavement that is in good condition.

The seal coat will provide a new wearing course which can restore friction to an existing low-friction surface. Well-maintained surfaces can be sealed with ¼ to 3/8 aggregate. This reduces materials costs, because less binder is required to attach the smaller particles. The smaller aggregate also results in a smoother road. Avoid using uncrushed aggregate such as pea rock. The round shape makes it more likely to roll on the pavement, causing raveling of the seal coat. When lighter color aggregates are used, the seal coat gives the appearance of a gravel road, and it can be very dusty if the aggregate has excessive fines. Using pre-coated chips will prevent dust problems and give the seal coat an appearance closer to that of an HMA road. The pre-coated chips also form a stronger bond with the binder, which decreases raveling.

Surfaces not recommended for this pavement

Thin HMA overlay, smooth seal, NovaChip®—Not recommended. Given the good condition of the pavement in this example, investment in these surfaces is likely to be premature.

HMA No. 2: Good to fair condition

- The pavement surface is oxidized and is raveling or poocking.
- Areas of polished aggregate are beginning to form.
- Thermal cracks and/or joint reflection cracks are beginning to widen or spall.
• Rutting, if present, is shallow.
• A centerline crack has formed.

Treatments placed on roads in this condition are maintenance treatments, not preventive maintenance.

Preconstruction
Cracks should be sealed two to three months before construction.

Surfaces suitable for this pavement

Seal coat—Recommended if rutting does not exceed moderate severity.

Ruts between ¼ and 1 inch deep can be reduced by filling them with slurry seal (see below). After the ruts are filled, a seal coat may be placed over the entire road to provide a uniform surface.

A seal coat effectively provides a waterproof surface to mitigate raveling, and it also seals thermal, reflected, and centerline cracks. A seal coat will also restore friction to a pavement with polished aggregate or low friction. Consider using a double seal coat or a cape seal to increase the robustness of the seal coat against distresses.

Slurry seal, micro-surfacing—Recommended.

Both slurry seal and micro-surfacing will provide a waterproof seal and good friction. They also make the pavement look like an HMA pavement and provide a good background for pavement markings. A slurry seal is recommended for pavements with low severity cracks that are not spalling. Because slurry seals are brittle, the surface will quickly reflect cracks, which may widen or spall. Micro-surfacing is more resilient and less likely to widen or spall at crack locations.

For rounded-over cracks, use either the slurry seal or micro-surfacing to level and fill in the crack before the entire surface is sealed. This will mitigate crack spalling and also restore a smoother ride to the pavement.

For ruts up to one inch deep, a good slurry seal mix can fill them when carefully placed. For deeper ruts under higher traffic, micro-surfacing is more stable and a more reliable choice. However, well-designed and placed slurry seal has reportedly successfully filled ruts deeper than one inch.

Both surfaces will have a higher tire noise until the aggregate in the seal is laid flat by traffic. The cost of a slurry seal is only slightly higher than a seal coat. The cost of micro-surfacing is one and a half to two times as expensive as a seal coat.

Thin HMA, smooth seal, NovaChip®—Recommended for the same reasons as the slurry seal and micro-surfacing.

These surfaces are effective at filling ruts. Although the design assumption is that these surfaces do not add structure, in actuality they do add a marginal amount of structure that can be helpful in life extension. Any cracking will reflect through to the new surface. These surfaces will provide a smooth ride and good appearance. In comparison to other treatments, these surfaces restore a completely “new road” look and feel and will likely last longer. The cost will be higher.

Surfaces not recommended for this pavement
Fog seal—Not recommended.

HMA No. 3: Fair to poor condition

• Pavement is oxidized and is raveling and pocking.
• The cracks in the pavement are wide and have spalled.
• Rutting is ½ to 1 inch deep, and longitudinal cracks are beginning to form in the rut.
• The centerline crack is spalling.
• Low-severity alligator cracking is beginning to form in the wheel paths.

Pavements with these conditions would need to be rehabilitated soon. Thin maintenance surfaces may be used as stopgap treatments, depending on the severity of the distresses, and may delay the need for rehabilitation. However, such use is rarely economical, and most stakeholders are disappointed by the results.

Preconstruction
Check drainage conditions and make changes if necessary. Perform full-depth patching for areas with structural failure. Cracks should be sealed two to three months before construction. High spots on the pavement can be milled down with a milling machine, and areas outside the wheel paths can be milled down...
to decrease depth of ruts. Any potholes should be excavated and replaced with a full-depth patch.

**Surfaces suitable for this pavement**

**Seal coat**—Possible stopgap life extension technique.

Because seal coats are flexible and can “glue” the surface together, they can be an effective stopgap procedure. The seal coat will seal the cracks and waterproof the surface, but it is likely that the cracks will reflect quickly because the emulsion will soak into the cracks leaving little on the surface to hold the chips. This reflection can be reduced by pre-sealing the cracks before placing the seal coat. Seal coats should not be used if rut filling is desired. Seal coats can be marginally effective on alligator cracks if traffic is light and the cracks don’t pump (proof roll test) under traffic.

**Thin HMA overlay, smooth seal, NovaChip®**—Marginally recommended.

These surfaces will add some structure to the pavement and will also fill in the ruts. Any areas of alligator cracking should be replaced with a full-depth patch, as the cracking will reflect quickly. These surfaces are effective at smoothing out the surface. If ruts are deep or there are variations in the grade, apply a scratch course to fill low spots before the surface course is applied.

**Surfaces not suitable for this pavement**

**Fog seal**—Not recommended.

**Slurry seal, micro-surfacing**—Usually not recommended.

If the original pavement has few cracks but has other distresses such as rutting, raveling, or bleeding, using a slurry seal or micro-surfacing may extend the life somewhat (see the slurry seal section in the HMA No. 2 example). If the cracking is dense and severe, these surfaces are not recommended because all the cracks will reflect quickly and little improvement will result.

**Common seal coat pavement conditions**

The examples in this section illustrate common seal coat pavement conditions and suggest possible thin maintenance surface selections.

The deterioration of seal coat pavements differs from that of HMA pavements because seal coats tend to have less structural capacity and more flexibility. They are therefore more prone to structural distresses such as rutting of base materials, alligator cracking, and longitudinal cracking in wheel paths. Bleeding and raveling are common when aggregate and binder application rates are not appropriate. Occasionally, seal coat pavements will develop transverse cracks.

**Seal coat No. 1: Excellent condition**

- Seal coat pavement displays little to no distress.
- The only distress might be light-severity raveling or loss of aggregate.

Surfaces recommended are intended for preventive maintenance.

**Preconstruction**

None.

**Surfaces suitable for this pavement**

**Fog seal**—Recommended.

A fog seal can mitigate light raveling and prevent more from occurring, because it is gluing the aggregate down to the base. It is possible to place a fog seal over a seal coat immediately after the seal coat has been placed to prevent raveling, mitigate dust, and improve the appearance of the pavement. The application of the fog seal should be designed so as to reduce the likelihood of bleeding. Keep in mind that a fog seal will reduce friction until the binder is worn off the tops of the exposed aggregate. This tendency can be reduced by applying sand. Also, the road will have to be closed until the emulsion has cured, which can take up to eight hours, depending on the weather.

**Seal coat**—Recommended every one to three years.

If the pavement is a full-depth seal coat, place a new seal coat every one to two years. Even though the seal coat may be in excellent condition, if cracks form and are not sealed, water will quickly weaken the subbase, causing failure.

**Smooth seal**—Recommended.

Smooth seals are intended to be placed on seal coats that are in good structural condition. Although the cost is much higher, the smooth seal should last
for 7–15 years or more, depending on the amount of traffic and the strength of the base. It will provide a smooth, clean, and uniform surface. Consider surfacing a few blocks per summer while maintaining others with a seal coat.

**Slurry seal**—Recommended if the existing seal coat is thick and the structural condition is good.

Slurry seal can have better public acceptance in comparison to a seal coat, because there is less dust and fly rock and the resulting surface is more uniform. On urban streets, layers of seal coating can build up the crown of the road so high that vehicles scrape the road as they enter and exit driveways. A slurry seal provides a thinner layer and slows the build up of the crown.

**Surfaces not suitable for this pavement**

**Micro-surfacing**—Not recommended. The extra cost of micro-surfacing is seldom justified for seal coat pavements which generally experience low traffic and may have marginal structural characteristics.

**Seal coat No. 2: Fair to good condition**

- Seal coat is displaying mild bleeding or raveling.
- Some cracks have formed.
- Ruts are beginning to form.
- Alligator cracking is forming and developing into potholes.

Depending on the amount of work necessary, the surfaces recommended are considered to be maintenance or stopgap.

**Preconstruction**

Patch potholes and consider full-depth patches for areas of alligator cracking. If there are large areas of alligator cracking, check drainage. Consider the possibility that the structure could be improved by improving drainage.

**Surfaces suitable for this pavement**

**Seal coat**—Recommended.

If the seal coat is raveling, a new seal coat will mitigate raveling and provide friction in areas that have lost large amounts of aggregate. If the seal coat is bleeding, applying a new seal coat with special attention to the application rates can prevent bleeding on the new seal coat. If bleeding is severe and located only in the wheel paths, consider pre-spraying the areas outside of the wheel path with binder, following immediately with a full-width pass of the emulsion. This will decrease the amount of binder in the wheel paths, preventing bleeding on the new surface.

The seal coat will effectively seal cracks; however, if the cracks are deep or wide, pre-sealing the cracks is strongly encouraged. If maintenance has been neglected for a time, applying a double seal coat will sometimes help “catch up.”

If the pavement is severely distressed and funds are available, the road should be pulverized and possibly mixed with stabilizing agents to provide a stabilized road (See appendix or SUDAS).

**Surfaces not suitable for this pavement**

**Fog seal**—Not recommended.

Smooth seal, slurry seal, micro-surfacing—Not recommended.

Any areas with structural distress must be replaced with a full-depth patch before placing the smooth seal, slurry seal, or micro-surfacing. If considerable patching is required, it may be a better investment to rebuild the road.

**Treatment for specific distresses**

**Bleeding**

- Place a new surface over the bleeding.
- If bleeding is severe and located only in the wheel paths, pre-spray the areas outside of the wheel path with binder, following immediately with another light, full-width pass of the emulsion. This will decrease the amount of binder in the wheel paths and prevent bleeding on the new surface.

**Bumps and sags, shoving and corrugation**

- Grind any bumps down with a pavement milling attachment. If unavailable, it may be possible to make some improvement by scraping with motor grader blades or loader buckets.
• When shoving and corrugation occurs, it usually indicates that the underlying pavement has insufficient stability to withstand traffic loads. The pavement will likely have to be removed and replaced to provide a permanent solution. Applying a TMS may delay the need for rebuilding.
• If slurry seal, micro-surfacing, or a thin HMA overlay is used, a scratch course is recommended to fill any sags or voids.

Cracking

Alligator cracking
• Removing distressed pavement and placing a full-depth patch works best.
• If the base or subgrade is soft, it should be removed and replaced or stabilized.
• Low severity alligator cracks can be seal coated or slurry sealed to slow down water penetration and “glue” the pieces together. This is most effective on low traffic roads if the alligator cracks are not pumping. A good way to test for pumping is to walk along a piece of equipment or a loaded tandem axle and watch to see if the pavement flexes under the load. This test is similar to proof rolling.

Block cracking
• Consider pre-sealing the cracks.
• For low-severity cracks, all surfaces are recommended for block cracking.
• For a pavement with a high density of cracks, seal coating may be most effective.
• As the severity or density of block cracking increases, a double seal coat becomes more desirable.
• If the block cracks are still hairline, a slurry seal or micro-surfacing will narrow the cracks. Micro-surfacing has greater resilience compared to a slurry seal, and may armor the edges of the crack for a time and prevent spalling.
• Thin overlays may be used to extend the life of the pavement. However, the cracks will reflect through to the surface, possibly two to four years after the overlay is placed.

Edge cracking
• Patch areas where the edge has spalled off the pavement.
• Seal cracks.
• Eliminate edge drop-offs between the pavement and granular shoulders to support the pavement and increase safety.
• If the distress is located where the ditch is deep and the shoulder is narrow, the edge of the road embankment may be sliding into the ditch.

Joint reflection cracking, transverse/thermal cracking
• Pre-seal cracks before placing a thin maintenance surface.
• Joint reflection cracking seldom results in a high density of cracking, because crack locations are limited to the location of original pavement joints in underlying layers.
• If hairline cracks exist, slurry seal or micro-surfacing will narrow the cracks. Micro-surfacing tends to be more resilient and will resist spalling and crack widening better under high traffic.
• On wider cracks, seal coats or thin HMA overlays are effective. Cracks will reflect through these surfaces, but with proper mix design and maintenance, spalling can be delayed for several years.

Longitudinal cracking (load related)
• Because load-related longitudinal cracks begin at the bottom of the pavement and move up, the crack is likely to be wider at the bottom than at the top. Cracks should be sealed as soon as possible.
• Seal cracks as soon as possible to prevent water infiltration and further weakening of the road.
• The use of thin maintenance surfaces will be a stopgap measure because the road is suffering a structural failure.

Longitudinal cracking (construction joint and paver segregation)
• If distress is low-severity, a fog seal strip over the area will likely slow further deterioration.
- A slurry seal strip over the defect can also be helpful.
- Seal coats can be effective for more advanced deterioration.

**Oxidation, weathering/raveling**

- All surfaces protect the pavement from oxidation. If the pavement suffers only from oxidation, a fog seal will be sufficient. It has the lowest cost and inflicts the least disruption.
- As oxidation turns to weathering and raveling, more aggressive treatments are required. As distresses become more severe, thicker applications such as slurry seal or micro-surfacing are desirable. Also consider using larger-sized (half-inch) aggregate or a double seal coat. A thin HMA overlay also addresses these distresses but cost more.

**Potholes, patching and utility cut patching**

- Remove and replace the pavement with a full-depth patch before applying a new surface. If the subgrade or base is soft or unstable, replace it.
- All surfaces can be successfully applied to a pavement that has patches in good condition.
- If a patch is in poor condition, replace it before applying a new surface.
- Seal cracks.
- The edges of patches can reflect through thin maintenance surfaces in a manner that is similar to that of cracks. If the patch density is low, slurry seal and micro-surfacing can provide a more uniform appearance, and reflected cracks will not be overly problematic. Micro-surfacing has greater resilience compared to a slurry seal and is less likely to spall or widen at cracks.

**Polished aggregate**

- All surfaces except fog seal are recommended for polished aggregate.

**Rutting**

- Slurry seals are recommended for ruts up to one-half inch.
- Micro-surfacing and thin HMA overlays are recommended for ruts up to one and a half inches.
- For ruts that are one-half to one inch deep, micro-surfacing should be placed in two lifts: a scratch course and a finish course. The scratch course fills ruts while the spreader box is allowed to drag on high spots in the pavement.
- For ruts deeper than one inch, a rut box should be used. A rut box has augurs that sweep larger pieces of aggregate into the bottom of the rut, resulting in a more stable mixture. Using a rut box requires two passes, one for each rut. Then a finish course is usually required to provide a surface with a uniform appearance.
- If deep ruts are filled in one pass, the road will have a blotchy appearance because the aggregate tends to sink to the bottom of the rut while the binder rises. This leaves dark spots on the road that appear to be bleeding. (According to anecdotal evidence from Iowa DOT personnel, this does not result in a noticeable loss of friction during skid testing.)
- Consider milling the pavement to reduce rut depth.
- If ruts are still progressing due to an unstable mix or a failing base or subgrade, rutting will reappear after a new surface is applied.