Microsurfacing Usage Guidelines

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Microsurfacing is used as a surface seal to establish skid resistance on pavements, to fill ruts in asphalt concrete pavements and chain-wear depressions on portland cement concrete pavements, to reduce weathering and raveling on asphalt concrete pavements, and to surface bridge decks. Usage guidelines for applying microsurfacing on asphalt concrete pavements were developed while working on a project for the Texas Department of Transportation (TxDOT). These guidelines are based on information collected from published literature, personnel experienced in using microsurfacing, TxDOT personnel, industry personnel, and the project staff’s experience developed during the project. Special attention was directed at identifying those pavement types, conditions, and problems that normally could be addressed with microsurfacing. Provided is the following information: a short description of microsurfacing, its use as a surface treatment, its use as a rut filler, the types of pavement problems for which the treatment would be appropriate, the requirements of the pavement for treatment with microsurfacing, recommended analysis procedures to decide if microsurfacing is appropriate for a selected section of pavement, layer thicknesses, and the time of opening to traffic.

Microsurfacing is a mixture of polymer-modified, emulsified asphalt cement; dense-graded, crushed mineral aggregate; mineral filler (normally portland cement); and water, often with other additives (normally similar to an emulsifying agent) (1). Microsurfacing is similar in appearance to a type II or type III standard slurry seal with a polymer-modified binder and a very good aggregate (2). Mixed in a truck-mounted traveling plant are the aggregate; mineral filler; polymer-modified, emulsified asphalt cement; water; and additives. The mixture is deposited into a spreader box pulled behind the truck-mounted traveling plant that distributes the mixture across the pavement surface. Compaction by rollers normally is not applied. The mixture is designed to allow the surface to be opened to traffic about one hour after placement during normal environmental conditions.

The mixture design normally defines the amount of polymer-modified, emulsified asphalt cement and mineral filler (cement) as functions of the amount of mineral aggregate (3). A recommended range of water is provided by most mixture designs, and the equipment operator changes the amount of water within that range to control the consistency of the mixture during placement. The equipment operator adjusts the amount of additive to control the time at which the emulsion breaks, which in turn affects the time at which traffic can use the finished surface. Changes in the moisture content of the aggregate, the humidity of the air, the ambient temperature, and the texture of the existing surface may require changes in the amount of water and additive needed to provide the desired end product.

Microsurfacing generally is used as a maintenance or surface treatment on an existing asphalt concrete-surfaced pavement. As a surface treatment, it provides a skid-resistant surface, and it reduces the amount of water that enters the pavement layers through the surface of the pavement. It also should reduce the amount of oxygen that enters the underlying asphalt concrete, reducing oxidation, weathering, and raveling. As a maintenance treatment, microsurfacing is used to fill ruts, restoring the transverse cross-section profile. Microsurfacing has been used on portland cement concrete-surfaced pavements and bridge decks; in these cases it is primarily used to develop surface friction or fill longitudinal depressions created by chain or studded-tire wear. This paper will address microsurfacing applied to asphalt-surfaced pavements.

The service life of microsurfacing applied to asphalt-surfaced pavements in the appropriate condition appears to be 7 or more years for relatively heavy traffic and may be considerably longer for low to moderate traffic (3). This assumes, however, that the microsurfacing is placed on a pavement surface that is in a condition appropriate for being treated with microsurfacing.

GENERAL DESCRIPTION

Although microsurfacing is a mixture of polymer-modified, emulsified asphalt cement; well-graded, crushed mineral aggregate; mineral filler (normally portland cement); water; and additives (normally similar to an emulsifying agent), the components of microsurfacing left on the surface (a dense-graded aggregate with an asphaltic binder) are similar to those found in hot-mix asphalt concrete. Microsurfacing, however, is applied at ambient temperatures, generally without compaction, allowing the construction of thinner surfaces than generally is possible with normal hot-mixed asphalt concrete materials and construction practices. The polymer-modified binder probably enhances the durability of the mixture compared to most thin surfacings using conventional binders. The 100 percent crushed, dense-graded, fine aggregate makes the microsurfacing more stable than similar materials such as slurry seals made with natural aggregates. Cement or lime normally is used as the mineral filler; the cement also acts as an accelerator affecting the breaking time of the emulsion. Both cement and lime used as mineral filler also may act as antistripping agents. Special additives, similar to the emulsifying agents, generally are used to control the break time, especially to increase the time to the initial breaking of the emulsified asphalt cement when applying microsurfacing during hot weather.

Microsurfacing generally can be opened to rolling traffic within an hour after application during normal weather conditions; however, climatic conditions affect this opening time. Cool, moist conditions require longer curing times before opening to traffic, and hot, dry conditions lessen the curing time before the surface can be opened to traffic. Heavy vehicles that stop or make sharp turns on the surface can mar or damage new microsurfacing for several hours after application, especially in very hot or cool weather (3).
MICROSURFACING AS A SURFACE TREATMENT

Surface treatments are used as preventive and corrective maintenance treatments. When used as a surface treatment, a single-layer application of microsurfacing generally is slightly thicker than the maximum size of aggregate used in the mixture.

Microsurfacing as a Preventive Maintenance Surface Treatment

As a preventive treatment, microsurfacing will reduce future deterioration by protecting the underlying layers. Air entering asphaltic pavement layers contributes to oxidative hardening of the asphaltic materials, which increases the stiffness and reduces adhesiveness, and water entering these layers carries dissolved oxygen and trace chemicals that also contribute to this hardening. Oxidation of the surface leads to weathering, raveling, and surface cracking; although these may not initially appear to be severe, the damage is progressive, getting worse with time. Reducing the permeability of the pavement by placing a protective layer of microsurfacing on the existing surface retards the development of weathering, raveling, and age-accelerated surface cracking, reducing future deterioration.

Although the application of microsurfacing does not increase the structural capacity of the pavement, it helps preserve it. Decreasing the permeability of the pavement reduces the amount of water entering the asphalt layer and supporting layers from the surface. Since most pavement-layer materials lose stiffness when moisture levels increase, reduction of moisture infiltration reduces this loss of strength, preserving the structural capacity of the existing pavement structure so that it can continue to meet its basic objective of supporting wheel loads imposed by traffic.

Microsurfacing also protects asphaltic pavement layers from destructive ultraviolet rays emitted by the sun. Although these rays only affect a very thin layer of asphalt, the thin damaged layer can be removed by traffic action, resulting in progressive damage as successive thin layers are damaged and removed, accelerating weathering, raveling, and surface cracking.

Microsurfacing as a Corrective Maintenance Surface Treatment

Following are some of the corrective capabilities of microsurfacing (3):

- Providing or restoring nonskid characteristics,
- Reducing entry of air and water into the existing asphalt concrete,
- Attaining a uniform appearance,
- Increasing visibility of pavement surface at night, and
- Possibly preserving the pavement’s structural strength.

Microsurfacing provides surface friction when skid-resistant and polish-resistant aggregates are used in the mixture. When microsurfacing is applied to a portland cement concrete surface, often the main benefit it provides is the increase in surface friction. Microsurfacing has been placed on pavements with moderate flushing and bleeding with some success. Two layers of microsurfacing generally are needed, however, to substantially reduce the probability of the underlying excess asphalt causing flushing in the microsurfacing. Adequate experience is not available at this time to quantify how long microsurfacing will prevent the excess asphalt from causing flushing in the microsurfacing or how severe a bleeding and flushing problem can be corrected with microsurfacing. Even when minor flushing through the microsurfacing occurs, however, it appears not to be a major problem as far as skid resistance is concerned (3).

Microsurfacing Advantages as a Surface Treatment

Rock loss and resulting windshield breakage do not occur with microsurfacing. Microsurfacing is more durable than a conventional slurry seal system, and it provides a reasonable service life on higher-volume roads. Microsurfacing applications are normally thin enough so that utility accesses and curbs do not need adjustments.

The general recommendations for using microsurfacing as a surface treatment are to use it in place of a conventional seal coat (aggregate seal) where the traffic volume is considered too high for a seal coat, to use it where normal rock loss and resulting windshield breakage potential encountered with seal coats are not acceptable, and to use it where vehicles perform too many turning and stopping movements for a conventional seal coat. Areas where microsurfacing often is considered an alternative to conventional seal coats include

- Approaches to major intersections,
- Urban arterials with an asphalt surface,
- Interstate pavements with an asphalt surface, and
- Other high-traffic asphalt-surface pavements.

If properly designed and applied to a properly selected road, microsurfacing can significantly extend pavement life.

Microsurfacing Limitations as a Surface Treatment

Microsurfacing is a thin layer of a relatively stiff material. It will not seal working cracks, and even if those cracks are sealed prior to applying the microsurfacing, most working cracks in the existing pavement will reflect through the microsurfacing relatively quickly. If cracking is a major problem in the pavement, then a treatment other than microsurfacing should be used. Most cases of microsurfacing loss from wheel paths within a relatively short period of time after application appear to be related to placing microsurfacing over pavements experiencing fatigue or alligator cracking (3).

Microsurfacing, like any other surface treatment, is not a cure-all treatment. Microsurfacing adds no structural strength to a pavement, nor does it correct excessive longitudinal roughness problems or seal larger-than-hairline cracks. To perform effectively as a preventive maintenance treatment, it should be applied before significant surface observable distress becomes obvious, especially cracking. At this stage, microsurfacing, like other surface treatments, can delay major maintenance or rehabilitation on a structurally adequate pavement for a considerable period and increase the time until a large amount of money is needed for corrective rehabilitation treatments.

Guidelines for Use as a Surface Treatment

The following guidelines are provided for using microsurfacing as a surface treatment:

- The pavement should be structurally sound and capable of supporting future traffic over the expected life of the microsurfacing.
• Microsurfacing should be used on high-volume rural highways; urban arterials; intersections; and other locations in which surface seals are needed but are not normally considered feasible.
• Transverse cracks should be sealed and localized areas of fatigue (alligator) cracks should be repaired prior to placing the microsurfacing.
• Other treatments should be considered if cracking is a major problem.

MICROSURFACING AS A RUT FILLER

Because microsurfacing initially is applied as a relatively fluid material, it can be used to level longitudinal rutting depressions. The polymer-modified asphalt cement binder and 100 percent crushed dense-graded aggregate generate a mixture stable enough to withstand traffic loads when applied at more than one maximum-size aggregate thickness, providing the stability needed for rut filling. Microsurfacing has been used successfully to fill ruts of 50 mm (2 in.) and deeper; however, this normally requires multiple applications of microsurfacing layers, which increase the cost above that required for a single application as a surface treatment (3).

Multiple Layers for Rut Filling

When ruts are present, but the average rut depth is less than about 18 mm (3⁄4 in.), two passes of the application equipment generally are required. The first layer, or “scratch coat,” is used to fill the ruts, and the second pass covers the surface with a final uniform application of microsurfacing. When ruts are deeper than about 18 mm (3⁄4 in.), a special spreader box, or “rut box,” is used with the truck-mounted mixer to fill the ruts. A separate pass of the equipment is used to fill the rut in each wheel path, and generally, a final application is made with a conventional spreader box to cover the entire lane. Ruts in excess of about 38 mm (1½ in.) deep generally require multiple applications with the special rut-filling spreader box to restore the original cross section.

A curing period of one day to a week generally is needed between successive layers of microsurfacing during normal construction weather. If the first layer is not adequately cured, it will stick to the tires of the truck-mounted mixer and associated delivery trucks, resulting in tearing the fresh microsurfacing from the previous surface during application of the next layer.

Advantages of Microsurfacing as a Rut Filler

Rutting in pavements can create a number of major safety-related problems including hydroplaning when the ruts are filled with water. Microsurfacing can be placed to fill these ruts relatively quickly, and the application can be done with minimum disruption of traffic. Since the microsurfacing is placed in a relatively fluid state, it fills the constantly changing contour of the rutting to a uniform level while providing a stable, rut-resistant material after curing.

Limitations of Microsurfacing as a Rut Filler

Rut filling will only be effective for a reasonable time if the rut is caused by mechanical compaction of the pavement structure. Fill-
the existing pavement and provide the desired thickness. When the existing pavement surface is nearly smooth or flushed, less microsurfacing material is needed to provide the desired thickness. If too little microsurfacing is placed on an open surface, individual pieces of aggregate will be caught by the spreader box and pulled along the road surface, creating unsightly drag marks. These drag marks are considered unacceptable on the final surface, and they should be eliminated from the final surface course. These drag marks, however, should be expected between wheel paths on “scratch coats” because the scratch coats are designed to fill low areas of shallow ruts without adding material to the area between the ruts, and the scratch coat will be covered with the final surface application, eliminating drag marks in the previous layer.

When the surface texture of the existing pavement is nonuniform, the surface of a single-layer microsurfacing application also may be nonuniform. If an existing pavement has patches or spot seals that have a different surface texture than the remainder of the pavement, the surface texture of the microsurfacing will be different above those patched areas compared to the remainder of the surface. If the wheel paths are smooth or slightly flushed while the areas between them have an open-surface texture, the surface of the microsurfacing will have a different appearance over the wheel paths than it will have between them. A scratch coat can be used as a first application followed by a final surface application in a two-stage process to create a more uniform final surface.

If the existing pavement exhibits minor to moderate flushing or bleeding, two application layers should be used. Experience shows that a two-layer application has been more successful than a single layer at preventing bleeding or flushing on the existing pavement surface from going through the microsurfaces.

If the pavement has ruts in excess of 6 mm (1/4 in.) but less than 18 mm (3/4 in.) in depth, a full-width scratch-coat application should be used to level the surface before a final surface application is placed. If the rutting is greater than 18 mm (3/4 in.) in depth, a rut-filling spreader box should be used to fill the rut in each wheel path separately before the final surface application is placed. Ruts in excess of 38 mm (1 1/2 in.) should be filled with multiple layers of microsurfacing placed using the rut-filling spreader box; the maximum microsurfacing thickness applied in a single application should not exceed 38 mm (1 1/2 in.). Each individual rut-filling application using a rut-filling spreader box should be slightly crowned to compensate for compaction that will be caused by traffic loads.

**TIME-TO-TRAFFIC GUIDELINES**

Rolling traffic normally can be permitted on microsurfacing in less than an hour after placement without damaging the pavement during normal construction weather; stop-and-go traffic, especially heavy vehicles, may require additional curing time. Currently there are no definitive field tests to determine when traffic can be allowed on microsurfacing. A subjective check can be made using a simple shoe test. If a person’s full weight can be placed flatly through the heel and sole of the shoe on the microsurfacing layer for about two seconds and no aggregate sticks to the shoe’s heel or sole when lifted from the surface, rolling traffic generally can be allowed to use the surface without causing significant damage. If a person’s full weight is placed flatly through the heel of a shoe on the surface of the microsurfacing and the heel is twisted about 180 degrees without the large aggregate being displaced, all types of traffic generally can be placed on the surface without causing significant damage.

Sharp turns and stopped traffic, especially heavy-vehicle traffic, can damage microsurfacing for several hours after application, especially in hot weather.

The time required before traffic can be allowed on the microsurfacing depends on the time it takes for the emulsion to break and the mixture to cure. As the temperature increases and the humidity decreases, the time it takes for the emulsion to break and expel the water decreases. In microsurfacing, portland cement normally is used as a mineral filler; however, it also affects the rate at which the emulsion breaks. As the amount of cement is increased, the time it takes for the emulsion to break and expel the water decreases. In the mixture design process, the amount of cement used in microsurfacing often is selected to control how long it will take for the mixture to reach a selected strength based on a torque test at room temperature. This is often used to establish the amount of cement that is used in the field.

Normally, during construction, the temperature is higher than the room temperature at which the amount of cement was selected. In such instances, the microsurfacing would be expected to break more quickly in the field than in the laboratory. To control the breaking and curing time in the field, special additives are used to retard the breaking time. They generally are similar to the emulsifying agent used in the emulsified, polymerized asphalt cement. If the amount of this additive is increased, the breaking time will increase. If the amount of the additive is decreased, the breaking time will decrease.

As the temperature increases during the day and the humidity decreases, the amount of additive normally is increased to maintain the desired breaking time.

In some instances, the conditions in the field may be so cool and moist that the microsurfacing will not break and cure quickly enough to allow traffic on it within the required time, even when no additive is being added to the mixture. If this occurs, the asphalt supplier may have to reformulate the emulsion so that it will break more quickly in the cool, moist weather. For some mixtures, the amount of cement used can be increased slightly to decrease the breaking time. This increase in cement content should be based on the information from the mixture design, and if too much cement is added, the emulsified asphalt cement in the microsurfacing can break in the mixing chamber of the truck or in the spreader box. Excessive amounts of cement also can create a brittle microsurfacing mixture. A trial increase of about 0.5 percent cement based on dry weight of the aggregate can be used to determine if the required breaking time can be achieved by adjusting the cement content in the mixture; the special additive may still need to be used to control the breaking time. If greater amounts of cement are required to achieve the desired break time, the emulsion should be reformulated since large increases also can affect the film thickness of the asphalt cement coating the aggregate. Generally, no more than about 3 percent cement by dry weight of aggregate should be in a microsurfacing mixture.

**WATER PERCENTAGE GUIDELINES**

The operator of the microsurfacing traveling plant changes the amount of water added to the microsurfacing mixture to control the consistency of the mixture. If the mixture is too dry, it will not flow across the spreader box and may create an uneven surface thickness and excessive drag marks. If the mixture is too wet, segregation of the mixture may occur, and the aggregate and emulsion may not be distributed evenly.
During the mixture design, an optimum water content and an allowable range normally are determined. During application of microsurfacing in the field, the amount of water needed in the mixture is affected by the amount of moisture in the aggregate, the ambient humidity, the temperature, and the amount of moisture the pavement surface absorbs. When the existing pavement surface condition, the moisture content of the aggregate, or the ambient humidity changes, the operator must change the amount of water added to the microsurfacing mixture to maintain the desired consistency. The amount of water added, however, should not be greater or less than the ranges established in the mixture design.

SUMMARY

Usage guidelines were developed to provide guidance on the pavements that should be considered as candidates for treatment with microsurfacing. These guidelines consider the following:

- Use as a surface treatment,
- Use as a rut filler,
- Types of pavements on which the treatment would be appropriate,
- Requirements of the pavement for treatment with microsurfacing,
- Recommended analysis procedures to determine that microsurfacing is appropriate for a selected section of pavement,
- Layer thicknesses, and
- Time to opening to traffic.

Microsurfacing generally will not be effective if it is applied to pavements that have working cracks, that are structurally inadequate, or that have unstable pavement layer materials. Microsurfacing applied to pavements in the appropriate condition provides seven or more years of service.

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