APPENDIX C

RESURFACING AND PAVEMENT PRESERVATION TREATMENTS

This Appendix contains brief descriptions of some preservation methods, and discusses those that have been evaluated by the Metro Nashville. Metro has conducted field evaluations of a number of maintenance and pavement preservation treatments under real conditions with 500-ft test sections on selected streets maintained by Public Works. Some products that have been evaluated include:

- Reclamite
- GSB 88
- Rejuvaseal
- PASS
- Re-Play (Soy)
- Crack Seal
- GSB-Restore
- Slurry/Micro
- Joint Bond
- Infrared Patching

The field evaluations will continue as new products are identified with promise to improve the Metro maintenance and pavement preservation program in a cost-effective manner.

The discussions below provide brief descriptions of various pavement preservation methods, selection criteria, materials and construction, and surface preparation, along with sources for more information.

C.1 THIN HOT MIX OVERLAYS

C.1.1 Definition

The thickness of thin hot mix asphalt concrete (AC) overlays is generally less than 2 inches (50 mm). This distinction is made because overlays that are more than 2 inches thick are usually associated with routine paving operations, whereas overlays that are less than 40 mm thick typically require special specifications. Also, such thin overlays provide a similar function, as do other thin pavement surfacings. Figure C.1 illustrates the processes involved in construction of thin overlays. Mill and overlay has been used by the Metro for many years; although this method of maintenance provides a good riding surface, it is not always the most cost-effective treatment.

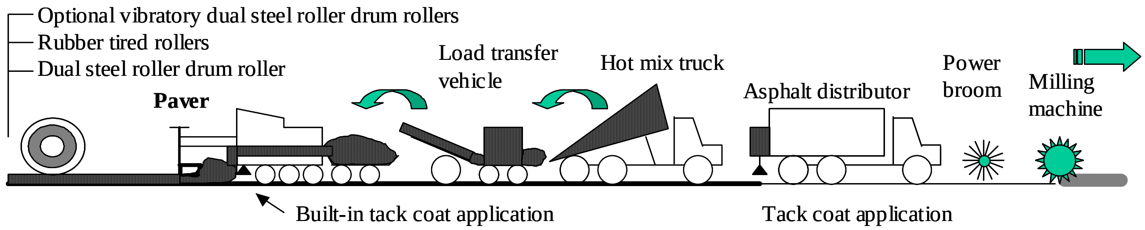

Figure C.1. Construction sequence for hot mix overlays with prior milling.

C.1.2 Selection Criteria

Thin AC overlays are typically used on structurally sound pavements to provide a new waterproof surface, to improve ride quality, to increase pavement friction and reduce noise. They can be also used as a preventive maintenance treatment to slow surface raveling, seal small cracks, and provide a waterproof surface. If thin AC overlays are applied to badly cracked AC pavement, the cracks will likely reflect through the new surface in a short time. Areas with significant load associated distresses, i.e., medium to high severity alligator cracking or rutting, are not candidates for thin overlays.

C.1.3 Materials and Construction

The two main types of hot mix used for thin overlays are dense-graded and open-graded mixes. Dense-graded mixes typically use sandy mixes with the largest aggregate particle passing ½-inch sieve. Open-graded mixes contain a large percentage of one-size coarse aggregate resulting in a mix with interconnected voids and high permeability. The existence of distresses such as segregation, raveling and block cracking, or conditions that do not permit raising of the pavement surface, may dictate a partial removal of the existing asphalt concrete by milling or precision milling prior to overlay.

C.1.4 Surface Preparation

Thin AC overlays should be constructed on an existing surface that is uniform and allows good bond with the overlay. Improvements to the existing surface before applying the overlay may include precision milling to improve ride quality and cross-section, application of a leveling course or a scratch course, patching, full-depth repairs, and application of a tack coat.

A tack coat is generally applied prior to placing a thin overlay in order to improve the bond between the existing surface and the overlay. The bond increases the strength of the pavement structure (by limiting slippage between layers) and the durability of the overlay (by reducing the possibility of delamination). Too much tack coat can be detrimental, particularly with conventional overlays causing bleeding in the overlay. A tack coat is also necessary to seal the pavement when open-graded overlays are used. Tack coats are typically 0.03 to 0.07 gal/yd^2 of asphalt emulsion SS-1 or SS-1h, CSS-1, CSS-1h, or RG 250.

C.1.5 Application

The thin AC overlay is constructed in two steps as a leveling or scratch course and a surface course. Both courses use the same material consisting of high quality crushed aggregate passing the 3/8-inch sieve and containing 6.0 percent of asphalt cement. The product can be constructed by most typical paving contractors using the following steps:

- A scratch (leveling) course is applied with a paving machine or a grader using a box-like attachment shown in Figure C.2. The scratch course is used to fill in depressions and ruts. The scratch coat is compacted by rubber-tired and steel wheel rollers.
- A 1-½-inch thick surface coat is then applied by a paver and compacted by rubber-tired or steel wheel rollers operating in a static mode.

Figure C.2. Application of a scratch coat of a densely graded hot mix by a grader with box-like attachment.

NovaChip, a proprietary ultra-thin hot mix overlay product, is typically 15 to 20 mm thick and contains an open-graded high quality aggregate passing the ½-inch sieve. A specialized paving machine with built-in application of a tack coat applies the mix. The application of a heavy tack coat applied just prior to the NovaChip mix is one of the strong advantages of this treatment. Special attention must be paid to handling the open-graded mix around pavement utility openings. NovaChip can improve pavement friction and provides a quiet pavement surface because of its porosity and surface texture (Figure C.3). It also reduces splash/spray during heavy rainfall. The thick emulsion tack coat of 0.2 gal per square yard achieves the impermeability of the surface. Figure C.4 compares the surface texture of NovaChip to a fine sand mix. NovaChip will be evaluated on a case-by-case basis dependent upon the type of facility and its condition.

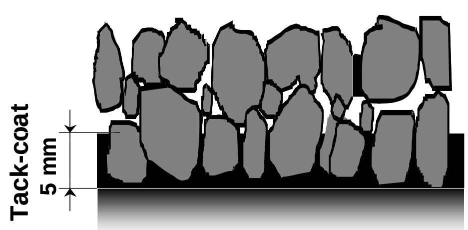

Figure C.3: Aggregate skeleton of Nova Chip surface.

Figure C.4. NovaChip surface on the left; sand mix surface on the right.

C.1.6 Resources

The publication *Thin Hot-Mix Asphalt Surfacings* by the National Asphalt Pavement Association (2001) contains description of several proprietary thin hot mix overlay products.

C.2 HOT-IN-PLACE RECYCLING

Hot-in-place (HIP) recycling (with or without integral overlay) is sometimes done to the depth of only 1 inch. Thus, even after sealing the recycled layer with a slurry seal, surface treatment, or with an integral hot mix overlay, the resulting thickness of the new and re-processed layers can still be considered a thin surfacing. The construction of HIP recycling with an integral overlay is schematically illustrated in Figure C.5.

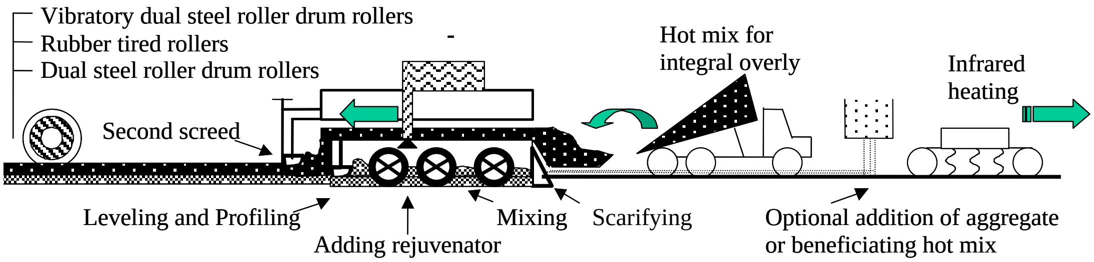

Figure C.5. Construction sequence for hot-in-place recycling with an integral overlay.

C.2.1 Materials and Construction

The recycled AC is typically mixed with a recycling agent, and can be further supplemented with pre-heated aggregate. The resulting recycled layer can be used as a driving surface or can be protected by a slurry seal, surface treatment or a thin overlay. If an integral overlay is used, the overlay serves as the new riding surface. The depth of the recycling layer ranges from 1 inch to 2 inches. The actual recycling depth may vary considerably depending on existing road conditions.

C.2.2 Selection Criteria

HIP recycling is suitable for structurally sound pavements with surface defects that affect mainly the top pavement layer, such as raveling and segregation, cracking, and rutting. The existing AC surface layer should be suitable for recycling. The layer should have a uniform composition (gradation, asphalt content, thickness) and materials of good quality (aggregate and asphalt binder). Material properties of pavements considered for HIP recycling should be thoroughly evaluated. Because of the size of a recycling train, HIP recycling is suitable for large projects with room to maneuver (e.g., on rural highways or on multilane arterial roads or streets).

C.2.3 Resources

The FHWA publication *Pavement Recycling Guidelines for State and Local Governments* (1997) describes all aspects of recycling of asphalt pavement materials to produce new pavement materials.

C.3 MICRO-SURFACING

Micro-surfacing is a mixture of polymer-modified asphalt emulsion, high-quality frictional aggregate, mineral filler, water, and other additives, mixed and uniformly spread over the pavement surface as a slurry. The construction of micro-surfacing using a self-propelled continuous feed mixing machine is schematically illustrated in Figure C.6 and shown on a photograph in Figure C.7.

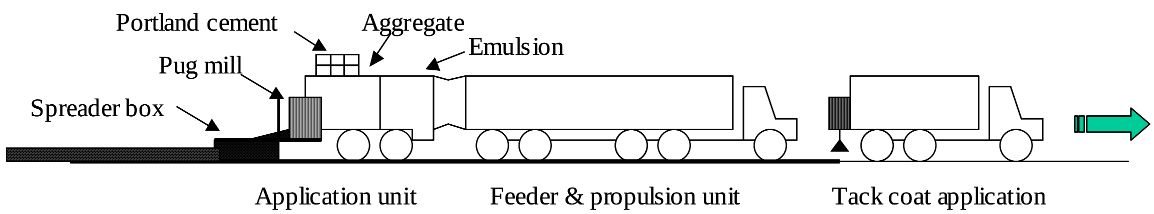

Figure C.6. Construction sequence for micro-surfacing.

Figure C.7. Truck-mounted self-propelled micro-surfacing machine (left) and finished surface using Type II aggregate (right).

C.3.1 Materials and Construction

Micro-surfacing mix is always designed by a contractor and consists of the following three main ingredients:

- Polymer-modified asphalt emulsion contains about 60 to 65 percent of asphalt cement. Polymers, typically latex, represent about 3 to 5 percent of the weight of asphalt cement. Altogether, micro-surfacing contains about 8 to 9 percent of residual asphalt binder. The addition of polymers improves bonding properties of asphalt cement and reduces its temperature susceptibility.

- Aggregate used for micro-surfacing is manufactured high-quality crushed stone, typically dense-graded. The International Slurry Surfacing Association recommends two types of gradations, one passing 0.25-inch (6.3-mm) sieve size called Type II, and another passing 0.375-inch (9.5-mm) sieve size called Type III. The Type III gradation is typically used on high traffic volume facilities and results in a minimum thickness of about 3/8-inch for a single course. The appearance of Type II micro-surfacing texture is shown in Figure C.7. The surface shows stony character of the texture typical for micro-surfacing.
- Mineral filler (Portland cement or hydrated lime) is used to control curing time of the mix. The amount of mineral filler is typically less than 1 percent of the total dry mix weight.
- Tack coat of RS-2P polymer modified emulsion applied prior to application of the Micro-surfacing.

C.3.2 Surface Preparation

Micro-surfacing is used to correct superficial distresses such as cracking, raveling and segregation, flushing, and loss of friction. Because micro-surfacing contains high-quality crushed aggregate, it is also used to fill in ruts and surface deformation to the depth of up to 1-½-inches. As a preventive maintenance treatment, it can be used to seal the surface from water infiltration when minor cracking or moderate raveling appears. Micro-surfacing has excellent frictional properties and is used on high-speed roads.

The surface on which micro-surfacing is applied should have uniform characteristics and provide a good bond. Areas that exhibit considerably more severe defects (raveling, cracking, or rutting) than the remainder of the section should be treated with an additional course of micro-surfacing (Figure C.8) or repaired by other means. When the surface of the pavement has minor distortions or has ruts exceeding about ¼-inch, two courses of micro-surfacing are recommended. The first (scratch) course is designed to improve the profile of the pavement, and the second course provides the wearing surface.

Figure C.8. Pre-treating of a severely raveled centerline joint with a light application of micro-surfacing prior to applying a regular course of micro-surfacing on the entire surface.

Many agencies rout and seal working cracks (e.g., transverse cracks) shortly before micro-surfacing is applied. However, micro-surfacing may not bond to the new crack sealant resulting in the loss of material. Some agencies require that routing and sealing of cracks is done a year before micro-surfacing. Other agencies carry out routing and sealing several months after micro-surfacing. This sequence is recommended because it eliminates the possibility of de-bonding and ensures that only cracks that are not sealed by micro-surfacing are routed and sealed.

C.3.3 Resources

The International Slurry Surfacing Association website www.slurry.org contains specifications and useful guidance (2003).

C.4 SLURRY SEAL

Slurry seal is a mixture of asphalt emulsion, graded fine aggregate, mineral filler, water, and other additives, mixed and uniformly spread over the pavement surface as slurry. Slurry seal is similar to micro-surfacing, but lacks the interlocking aggregate skeleton formed by crushed aggregate particles. Also, slurry seal emulsion may not be polymer-modified. The construction of slurry seal using a self-propelled truck-mounted mixing machine is schematically illustrated in Figure C.9.

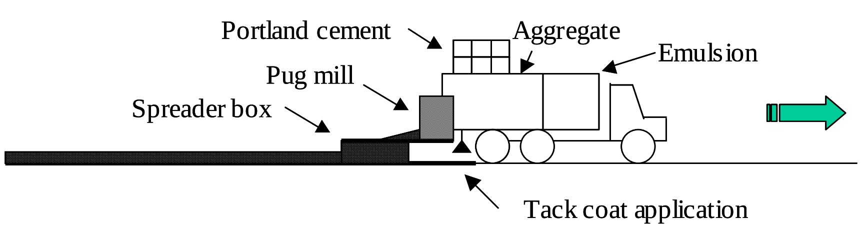

Figure C.9. Construction sequence for slurry seal.

C.4.1 Materials and Construction

Asphalt emulsion used for slurry seal work is typically cationic and contains about 60 to 65 percent of residual asphalt cement. The finished product contains 9 to 10 percent of asphalt cement. Aggregate used for slurry seals should be crushed high quality dense graded aggregate. Its gradation generally follows one of the three gradation types recommended by the International Slurry Surfacing Association. The Type I is used for residential streets; Type III for primarily roads and expressways. The thickness of a single application of Type I slurry seal is typically less than ¼-inch.

Mineral filler (Portland cement or hydrated lime) is used to control curing time of the mix (break time of the emulsion). The amount of mineral filler is typically less than 1 percent of the total dry mix weight.

C.4.2 Surface Preparation

Slurry seals are used to correct superficial distresses such as raveling and coarse aggregate loss, seal small cracks, and improve pavement friction. They are also used as a preventive maintenance treatment to seal pavement surfaces from intrusion of water and slow surface oxidation and raveling. Slurry seals are effective where the primary problem is hardening of asphalt binder resulting in minor cracking and raveling. Slurry seals will not perform well if the pavement has moderate or severe cracks, or progressive rutting.

The surface on which a slurry seal is applied should have uniform characteristics and provide a good bond. If defects such as moderate or severe raveling, cracking, or rutting occur intermittently or frequently, the section is probably not a good candidate for slurry sealing. Working cracks, such as transverse cracks, should be sealed, preferably after slurry sealing.

C.4.3 Resources

The International Slurry Surfacing Association website www.slurry.org contains specification for slurry seal and useful technology tips (2003).

C.5 SURFACE TREATMENT

Surface treatment (also called chip seal) is the application of asphalt binder immediately followed by an application of cover aggregate, to any type of pavement surface. Typically, surface treatments are applied on top of a granular base producing surface-treated pavement. Surface treatments can be also applied to new or existing AC pavements as a preventive or corrective maintenance treatment. An illustration of a surface treatment operation is shown in Figure C.10.

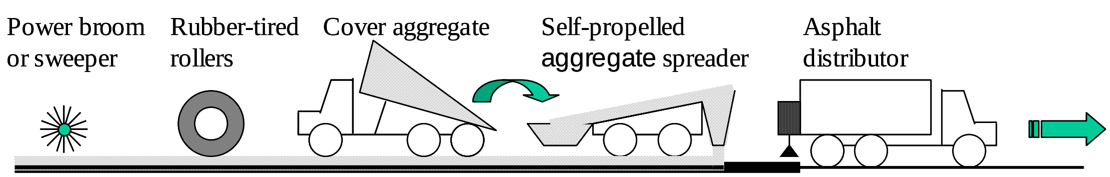

Figure C.10. Construction sequence for surface treatment.

C.5.1 Materials and Construction

Typically, the asphalt binder is asphalt emulsion applied at an elevated temperature using an asphalt distributor as shown in Figure C.11. The selection of the type of asphalt emulsion depends, in addition to the availability of the emulsion, on several factors:

- Cationic emulsions work best with sandstones and granites (negatively charged aggregates); anionic emulsions are most suited for limestone and dolomite aggregates.
- Polymer-modified emulsions are typically specified for applications on asphalt concrete surfaces.
- Rapid setting emulsions are generally recommended because of their less stringent weather restrictions.

The emulsion typically has a brown color that changes into black as the emulsion cures. Nozzles on the spray bar provide desired coverage of the surface.

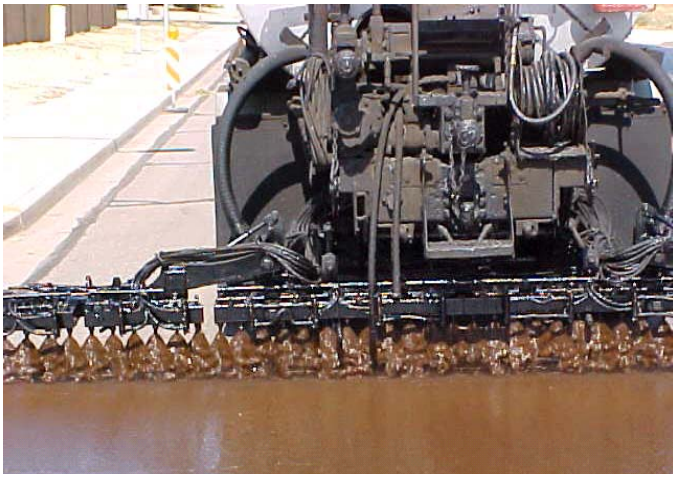

Figure C.11. Asphalt distributor applying emulsion.

The cover aggregate can be either one size, (open-graded) as shown in Figure C.12, or multiple sizes (dense-graded) as shown in Figure C.13. Surface treatment using open-graded aggregate (or chips) is called chip seal. The selection of aggregates depends, on several factors:

- Open-graded aggregate should be of high quality and washed (dust free). Such aggregate is typically available only from large commercial producers.
- Graded aggregate is less expensive and requires less emulsion.
- Rural or urban setting. Initial traffic on graded aggregate may produce excessive dust; a one-size uniform aggregate free of dust and fines is recommended.
- The use of one-size aggregate reduces the amount of excess aggregate and is preferred for high traffic volume roads.

The design of aggregate surface treatments calls for about 70 to 80 percent of the aggregate imbedded by the binder. This requires a proper balance between the amount of emulsion applied to the surface and the amount and type cover aggregate. Design procedures are available to determine application rates and take into account the type and porosity of the surface, size, type and shape of the cover aggregate, and traffic volumes.

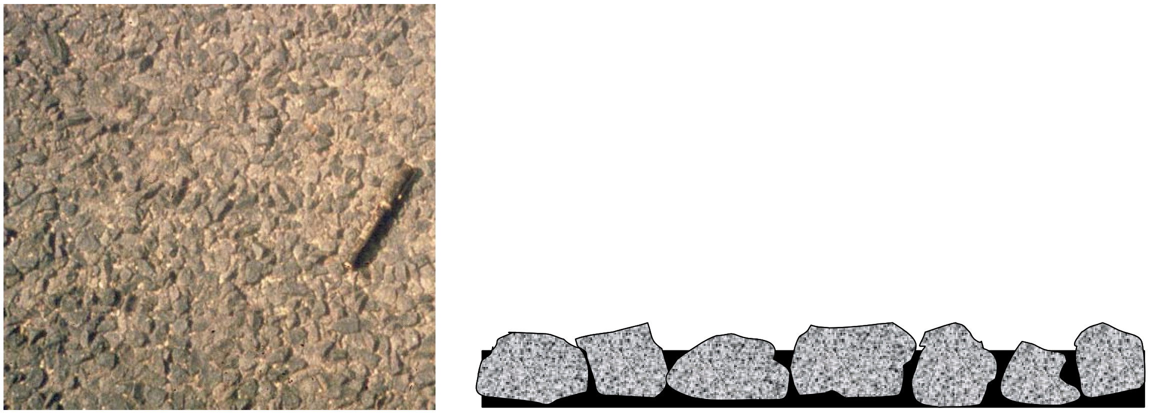

Figure C.12. Surface of a newly constructed surface treatment using uniform size aggregate.

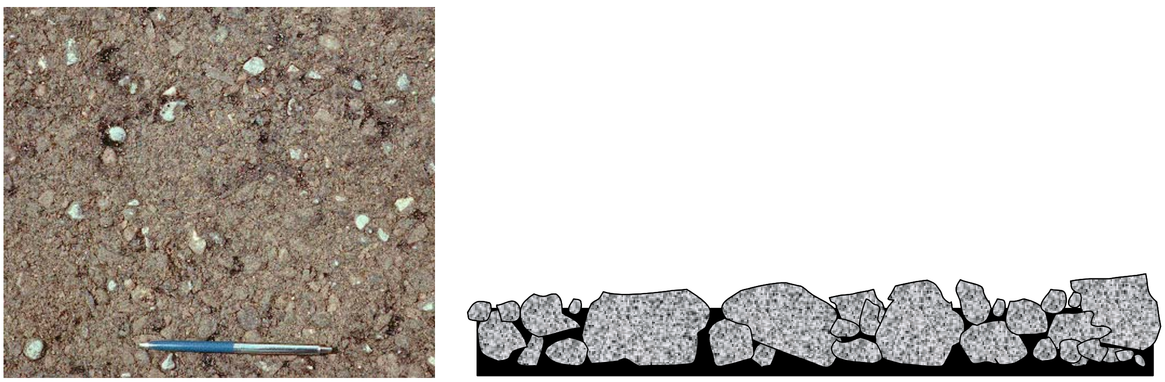

Figure C.13. Surface of a newly constructed surface treatment using graded aggregate with fine particles.

Figure C.14 shows an example of emulsion application rates for chip seals applied to an asphalt concrete surface. It should be noted that the application rate of the emulsion is decreasing with the increasing traffic volumes.

Modern asphalt distributors that can automatically maintain selected application rates regardless of the distributor to speed facilitate the need for accurate application of the binder and aggregate cover. Newly constructed surface treatments need to be protected from high-speed traffic for several hours after construction, and the public needs to be protected from loose chips and dust.

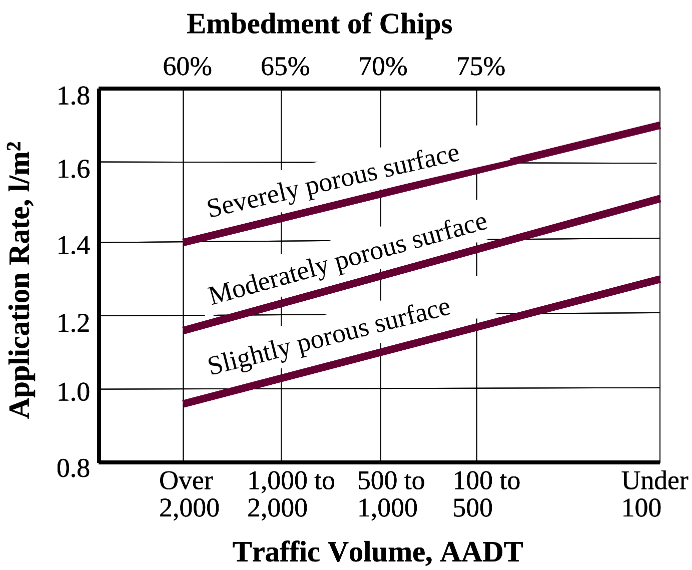

Figure C.14. Example of application rates for asphalt emulsion. Higher traffic volumes require lower application rates.

Rolling of the cover aggregate with a pneumatic roller is critical to success. The rolling embeds the chips into the asphalt and rolls them so that the least dimension is vertical. Pneumatic rollers conform to the shape of the roadway and therefore provide equal pressure to uneven spots. This also minimizes the amount of loose aggregate. Figure C.15 illustrates the effects of rolling.

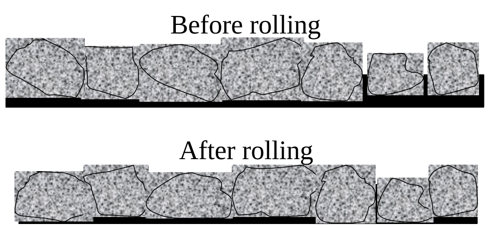

Figure C.15. Effects of rolling.

Some agencies remove excess aggregate aggressively, other agencies prefer to leave excess aggregate on the road and “live with it”, waiting until the access aggregate is dispersed by traffic. On roads with high traffic volume, the removal of excess aggregate is required for safety reasons. For the surface treatment itself, it is preferable to leave some “excess” aggregate on because it can be imbedded by traffic as aggregate particles rotate, imbed, and create additional openings in the mat.

Surface treatments applied to existing AC pavements can be used as preventive or corrective treatments. As a preventive treatment the surface treatment is primarily used to seal the surface with non-load associated cracks and raveling. As a corrective measure, surface treatments are used to restore skid resistance and to maintain wearing surface on thin AC pavements.

The surface on which a surface treatment is applied should have uniform capacity to absorb emulsion. If the pavement has, for example, areas of raveling or segregation, the raveled and segregated areas should be pre-treated (e.g., by priming or spray patching). If left untreated, these areas will absorb emulsion and will fail to have enough binder to seal the surface and retain cover aggregate -- precisely in the areas where the pavement needs the protection most. On the other hand, an increase in the emulsion application rate to match raveled and segregated areas may result in flushing elsewhere. Working cracks, such as transverse cracks, should be sealed, preferably after the surface treatment application.

C.5.2 Resources

Several agencies have published recommendations for the design construction of surface treatments including Ontario Ministry of Transportation (Cooper and Aquin, 1983) and Minnesota Department of Transportation (Janish and Gaillard, 1998). Practical handbooks were also published by The Asphalt Institute (1969) and by Asphalt Emulsion Manufacturers Association (no date).

C.6 SURFACE SEALS

Surface seals consist of a sprayed application of a bituminous material or specialty product, to the surface of existing AC pavements. Surface seals that apply diluted asphalt emulsion are also called fog seals. Some agencies or suppliers recommend light sanding of restorative seals (about 1-3/4 pound of sand per square yard). The application process is illustrated in Figure C.16.

Figure C.16. Construction sequence for restorative seal.

Surface seals are used on asphalt pavements within the first few years of their existence as a preservative for retarding the natural oxidation process and giving effective treatment for solving specific pavement problems such as raveling and oxidation.

The Metro has evaluated some surface seals and found PASS to provide satisfactory results; the Metro has adopted PASS into its preservation program. PASS is a polymer-modified asphalt surface sealer, a type of fog sealer. Rejuvenates and seals worn asphalt. It fills cracks and provides a durable membrane to resist reflective cracking

GSB 88, introduced in 1988, is a specialty product currently under evaluation by the Tennessee DOT. It is used on pavements that are less than 5 years old in order to seal the surface and prevent weathering and oxidation. Metro experience with GSB 88 is that it takes too long to cure, stays tacky too long, and does not provide enough material composition – too thin.

GSB Restore was found to be better than GSB 88 for penetration into the pavement surface with greater material composition. It is still under evaluation by the Metro.

Another product, RejuvaSeal, is proclaimed to seal, protect, and revitalize asphalt pavement surfaces. It penetrates the surface of asphalt; reduces viscosity and brittleness in the top 3/8 inch of asphalt while significantly increasing ductility and flexibility. Asphalt surfaces treated with RejuvaSeal are fuel, water, and chemical resistant. The Metro experience with this product indicated a strong coal-tar smell with unfavorable public perception; the smell is too strong for application on residential streets.

A product called Re-Play is also under evaluation. This sealant is made for soy oil. It has a slight but not unpleasant odor.

C.6.1 Selection Criteria and Surface Preparation

Surface seals are used to prevent oxidation and hardening of asphalt cement and to seal minor cracks. These seals can also slow the progression of raveling and aggregate loss. The pavement should be in good condition and should be broomed before the emulsion is applied.

C.6.2 Materials and Construction

Application rates for GSB 88 is .10 to .15 gallons per square yard. There is some concern that this product could cause a reduction in pavement friction.

PASS is 67% asphalt; 20% rejuvenator; 2% polymer. PASS applications cost only about 1/8 of the cost of traditional resurfacing using milling with 1.5 inch AC overlay.

C.6.3 Resources

A handbook by Emulsion Manufacturers Association provides guidelines for the use of restorative seals using asphalt emulsions.

C.7 SURFACE ABRASION

Surface abrasion includes diamond grinding, micro-milling, precision milling and other techniques that remove unevenness from the pavement surface, or improve its texture, and leave an abraded surface that is used as a driving surface. The operation is illustrated in Figure C.17.

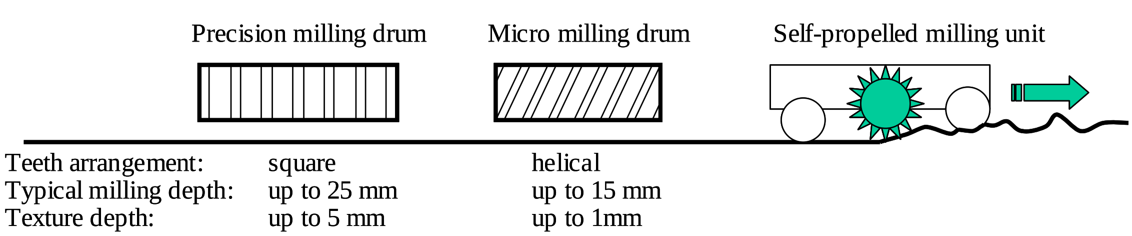

Figure C.17. Construction sequence for micro-milling or precision milling.

C.7.1 Selection Criteria

Surface abrasion techniques can smooth out stepping at transverse cracks, wheel track rutting and improve pavement friction. The pavement should have sufficient structural capacity so that the reduction in thickness is not of concern. Figure C.18 shows an example of pavement surface where micro-milling was used to reduce rutting and improve smoothness; the milled surface on the right has darker color and has groves with peak-to-peak distance of about 5/8 inch.

Figure C.18. Micro-milling application to reduce rutting and increase smoothness.

C.8 REJUVENATORS

Rejuvenators consist of a sprayed application of a bituminous material or specialty product, to the surface of existing AC pavements for the purpose of replenishing the lighter oils and softening a weathered surface. The Metro field trials found Reclamite to do a good job of rejuvenation, and Metro has adopted it to rejuvenate and protect pavements that are 2 to 3 years old with an OCI>80.

C.8.1 Selection Criteria

Rejuvenators are used on AC pavements that have oxidized and hardened; it is not suited for sealing cracks or for use on rutted pavement. It will seal minor cracks and soften the asphalt cement in the AC mix. These seals can also slow the progression of raveling and aggregate loss. The pavement should be in good condition and should be broomed before the emulsion is applied.

C.8.2 Materials and Construction

Reclamite is a widely recognized rejuvenator with many years of experience. It has been evaluated by many agencies including the U.S. Army Corps of Engineers. Studies have documented the ability of Reclamite to lower the viscosity of the asphalt binder in an AC pavement, to reduce the incidence of small cracks, and to reduce fines loss over a period of at least 3 years. Another rejuvenator that has some experience in Tennessee is RejuvaSeal. RejuvaSeal penetrates from 1/8 inch to ½ inch into the AC surface. Figure C.19 shows the application process.

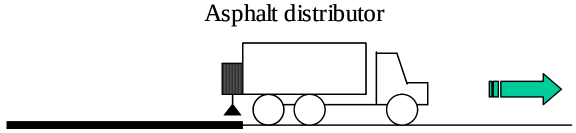

Figure C.19. Construction sequence for rejuvenators (note that light sanding is sometimes used).

Reclamite has been used extensively throughout the State of Tennessee with reported good success; examples are in cities of Oak Ridge, Athens, Clarksville, Lebanon, Spring Hill, Columbia, Kingston, and others. Oak Ridge currently treats about 5 percent of its streets with Reclamite each year.

The recommended procedure for using Reclamite is to:

1. Sweep street
2. Apply rejuvenator with asphalt distributor
3. Hand spray corners and hard to reach areas
4. Cover with sand or screenings after penetration has occurred (after about 1 hour)
5. Sweep up sand after 24 hours
6. Dark color fades in about 45 days

These products cost about $0.65 to $0.85 per square yard in place.

Figure C.20 shows the application and results of the Reclamite field trials in Nashville.

Figure C.20. Reclamite application on field section in Nashville.

C.8.3 Resources

"Evaluation of Rejuvenators for Bituminous Pavements," U.S. Amy Engineer Waterways Experiment Station, Report Number AFCEC-TR-76-3, February 1976.

C.9 CRACK SEALING

The purpose of sealing cracks in asphalt concrete pavement is to protect the pavement structure from premature failure; it is the most common maintenance option to help protect the pavement structure. The sealant protects the pavement by minimizing moisture infiltration through the crack opening and preventing the retention of debris in the crack, as shown in Figure C.21. When sealing is performed at the proper time, using the appropriate materials and procedures, the life-cycle performance of the pavement can be increased and maintenance costs reduced. Crack sealing has been implemented in the Metro.

The objectives of crack sealing are to:

- Reduce moisture infiltration
- Reduce incompressible material in cracks

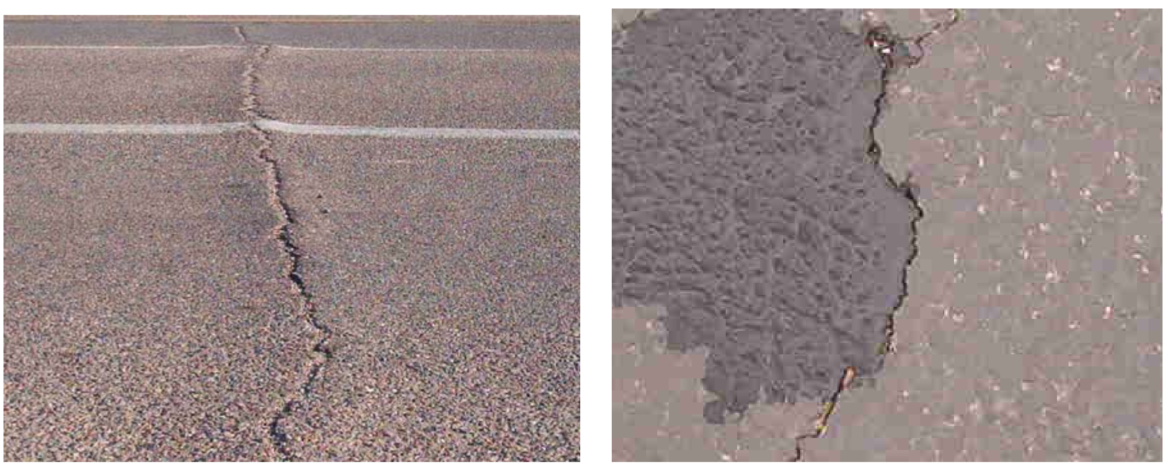

Figure C.21. Both water and incompressibles enter cracks that are not properly sealed.

C.9.1 Selection Criteria

Crack sealing works best when applied to:

- Relatively new pavement surfaces
- Pavements with good structural support
- Little or no secondary cracking
- Little or no raveling at crack face
- Cool weather (fall or spring)
- Proper preparation (clean and dry)

C.9.2 Materials and Construction

Routing adds up to 50% to the sealant life at 10% added cost. Figure C.22 shows the routing and cleaning operation. Figures C.22 and C.23 show the proper application of the sealant to achieve the overband. Equipment to prepare and apply cracking sealant costs about $50,000.

First, the cracks are cleaned and dried using a hot compressed air heat lance. Then, the cracks are filled with hot poured rubberized joint and crack sealant. It is often placed in advance of overlays and surface treatments to improve performance.

Figure C.22. Routing and cleaning are important to good seal performance.

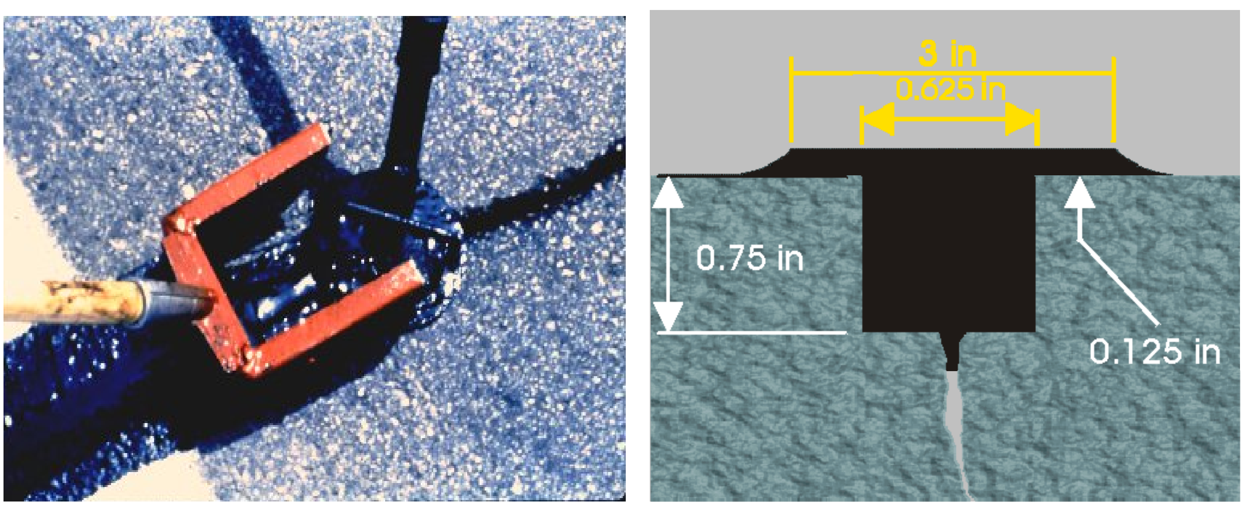

Figure C.23. Application of sealant to achieve overband.

C.9.3 Resources

Manual of Practice- FHWA-RD-99-147, "Materials and Procedures for Sealing and Filling Cracks in Asphalt-Surfaced Pavements" (February 2001)

Available through Turner-Fairbanks Highway Research Center, 6300 Georgetown Pike, McLean, VA 22101-2296; www.tfhrc.gov

U.S. Departments of the Army and Air Force, TM 5-822-11/AFM 88-6, Chapter 7 "Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements," Washington, D.C.

C.10 INFRARED PATCHING

This technology uses infrared to heat existing AC surfaces and blends in new AC mix to create a joint-free integral patch. The machine is capable of heating the existing AC to a depth of approximately two inches without oxidation or burning. No flame is in direct contact with the existing surface. Infrared asphalt recycling equipment uses "invisible heat" to emplace recycled asphalt. The equipment produces intense infrared wavelengths that reach temperatures near 1200 degrees Fahrenheit and directs them onto the bituminous surface that absorbs the wavelength and creates energy in the asphalt. The energy is heat and this heat conducts through the asphalt to the depth necessary for the scarification and repair of the damaged asphalted area.

C.10.1 Selection Criteria

Infrared asphalt recyclers are a cost-effective method of asphalt repair. Infrared repair techniques are faster than cutting out and replacing asphalt, and the resulting sealed joint is much more difficult for water to seep into. Infrared asphalt recyclers warm the existing asphalt in and around the repair area to over 300 degrees Fahrenheit - the same temperature that new asphalt is when manufactured at the plant. The softened asphalt can be scarified to mix in hot liquid binder and fresh asphalt, if needed, before compaction

Infrared patching seems to work very well but there it is new enough that there is limited competition for bidding. Experienced contractors are needed to level the playing field. The Metro has implemented infrared patching on some city streets.

C.10.2 Materials and Construction

Infrared heaters offer reliable operation in all weather conditions. High-pressure LP gas fired systems stay lit despite high-winds. Heat output is adjustable to allow infrared penetration for varying asphalt depths. Multi-heat zones allow heating of smaller areas. A self-propelled system allows the unit to easily be moved from patch to patch.

Metro Nashville has evaluated the infrared technique for patching and found it to be very satisfactory. Figures C.24 and C.25 highlight the patching procedure as used in the Metro.

C.10.3 Resources

Manufacturer literature.

Figure C.24. Heating area to be patched with Infrared machine.

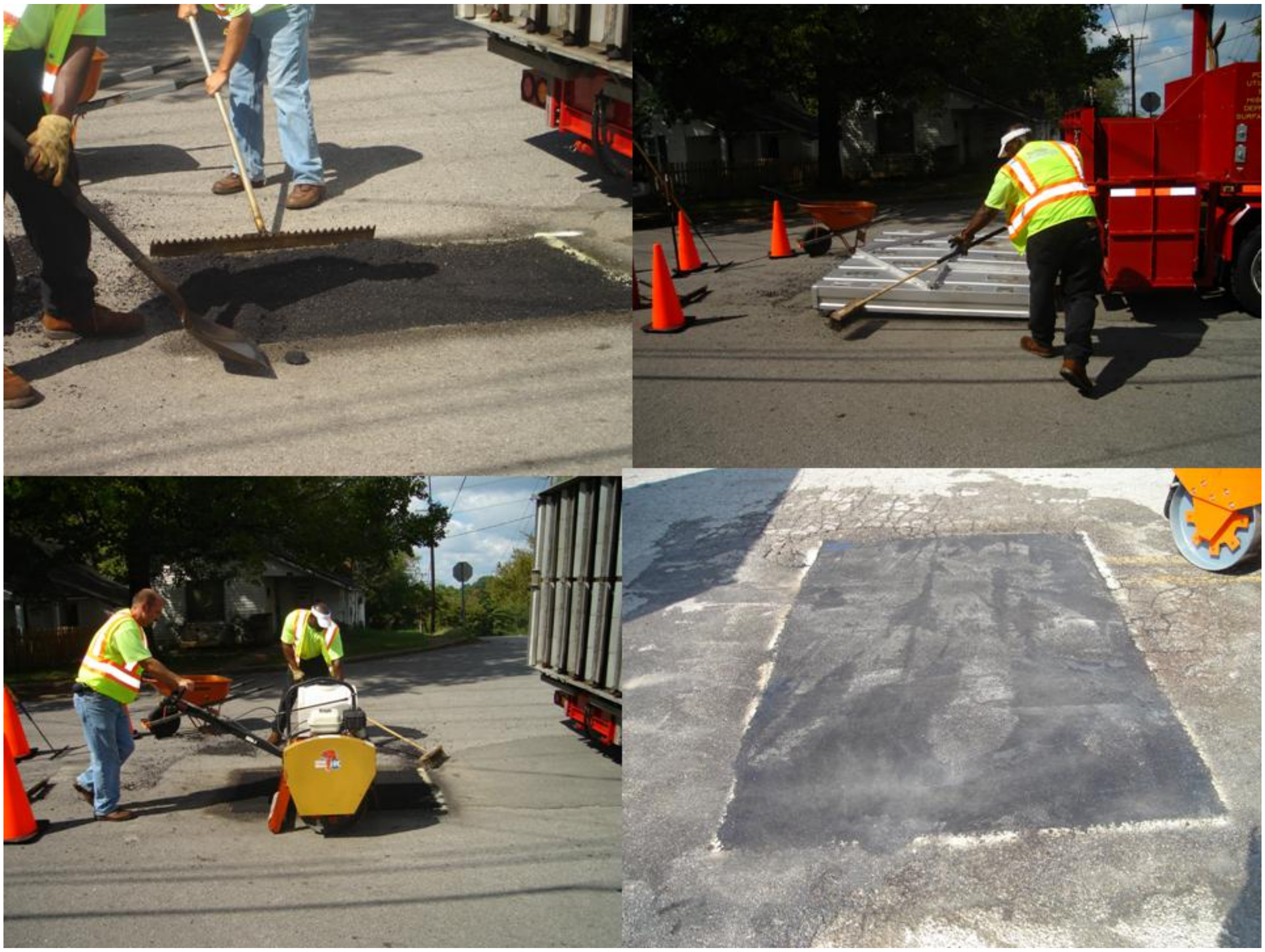

Figure C.25. Adding new mix heating, and compaction.

C.11 WARM MIX ASPHALT

European countries are using technologies that appear to allow a reduction in the temperatures at which asphalt mixes are produced and placed. These technologies have been labeled Warm Mix Asphalt (WMA). The immediate benefit to producing WMA is the reduction in energy consumption required by burning fuels to heat traditional hot mix asphalt (HMA) to temperatures in excess of 300° F at the production plant. These high production temperatures are needed to allow the asphalt binder to become viscous enough to completely coat the aggregate in the HMA, have good workability during laying and compaction, and durability during traffic exposure. With the decreased production temperature comes the additional benefit of reduced emissions from burning fuels, fumes, and odors generated at the plant and the paving site.

There are three technologies that have been developed and used in European countries to produce WMA:

1. The addition of a synthetic zeolite called Aspha-Min® during mixing at the plant to create a foaming effect in the binder.

2. A two-component binder system called WAM-Foam® (Warm Asphalt Mix Foam), which introduces a soft binder and hard foamed binder at different stages during plant production.
3. The use of organic additives such as Sasobit®, a Fischer-Tropsch paraffin wax and Asphaltan B®, a low molecular weight esterified wax.

The Aspha-Min and Sasobit products have been used in the United States. A fourth technology has been developed and used in the United States to produce WMA; this fourth process is plant production with an asphalt emulsion product called Evotherm™, which uses a chemical additive technology and a "dispersed asphalt technology" delivery system.

All four technologies appear to allow the production of WMA by reducing the viscosity of the asphalt binder at a given temperature. This reduced viscosity allows the aggregate to be fully coated at a lower temperature than what is traditionally required in HMA production. However, some of these technologies require significant equipment modifications.

This technology could have a significant impact on transportation construction projects in and around non-attainment areas such as large metropolitan areas that have air quality restrictions. The reduction in fuel usage to produce the mix would also have a significant impact on the cost of transportation construction projects.

C.11.1 Selection Criteria

The Metro plans to conduct evaluation of WMA and determined if it has a place in the maintenance and preservation program.

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