Thin Maintenance Surfaces

A. General

Seal coats, slurry seals, microsurfacing, and fog seals are termed thin maintenance surfaces or TMS. These thin maintenance surfaces can be a cost effective approach to maintaining flexible pavements. Studies have shown that agencies can maintain a city street or county road network in better condition at lower costs through the use of TMS. Project selection, treatment selection, and timing are critical to the use of TMS.

Since TMS do not involve increasing the structural carrying capacity of a street, it is vitally important to apply the appropriate treatment prior to the start of pavement deterioration. Pavement condition, traffic volumes, materials availability, roadway classification, and local preference must be evaluated before determining the type of TMS to use. General uses for TMS are noted in the following table:

Criteria	Seal Coat	Slurry Seal	Microsurfacing
Traffic Volume:			
Low (< 2,000 vpd)	Recommended	Recommended	Recommended
Medium (2,000 to 5,000 vpd)	Marginal	Marginal	Recommended
High (> 5,000 vpd)	Not Recommended	Not Recommended	Recommended
Bleeding	Recommended	Recommended	Recommended
Rutting	Not Recommended	Recommended	Recommended
Raveling	Recommended	Recommended	Recommended
Cracking			
Slight	Recommended	Recommended	Recommended
Moderate	Recommended	Not Recommended	Not Recommended
Low Friction	May improve	May Improve	May Improve
Snowplow Damage	Most susceptible	Moderately susceptible	Least susceptible

Source: Jahren, 2003

Design of these TMS treatments must take into account the type of pavement distress that is being addressed with the proposed project. It may be necessary to complete crack filling, patching, or other maintenance activities prior to implementing the TMS.

B. Seal Coat

A seal coat is a single layer of asphalt binder that is covered by embedded aggregate with its primary purpose to seal fine cracks in the underlying pavement and retard water intrusion into the pavement and subgrade/subbase. The aggregate protects the asphalt binder layer and provides macrotexture for improved skid resistance. Seal coating is also a cost effective way to address bleeding and raveling. Most often, the asphalt binder is an emulsion. Cutback asphalts may be used as well. Emulsified asphalt is a mixture of liquid asphalt and water. A cutback is a mixture of liquid asphalt and a distillate, such as kerosene or fuel oil. The aggregates are typically less than 1/2 inch in size.

One of the most critical factors in the design is to determine the quantities of asphalt binder and aggregate. The goal should be to have the single layer of stone 70% into the asphalt binder layer with little or no stones to clean up. In order to attain that goal, the designer must take into account the traffic volume; the absorption of the binder into the cover aggregate; the texture of the existing pavement; and size, shape, and gradation of the aggregate. Seal coat projects have an expected life span of 4 to 6 years.

Seal coating is recommended for low and medium volume roadways with low speeds due to the increased chance for insurance claims for vehicle damage from the loose rock as traffic volumes and speed increases. In addition, the impact to the public is compounded on high volume roadways due to the time the facility is out of service, generally 24 hours. As traffic volumes increase, it becomes more critical to include very high quality, durable aggregates in the mix design.

Selection of the asphalt binder is important to the success of the project. Although cutback asphalts can be used, their use has rapidly declined over the years due to the costly and harmful solvents used. Typically, asphalt emulsions are used. They are made up of asphalt cement, water, and an emulsifying agent (surfactant). The asphalt cement is typically in the same range as is used for hot mix production and makes up about 2/3 of the volume of the binder. Water provides the medium to keep the asphalt in suspension. The surfactant (usually soap) causes the asphalt particles to form tiny droplets that remain in suspension in the water, and it determines the electrical charge of the emulsion. It is important that the emulsion and the aggregate have opposite electrical charges in order to maximize the bond between the emulsion and the aggregate. Since most aggregates have a negative charge, emulsions such as CRS-2P with a positive (cationic) charge are used.

Cover aggregate should be clean and dust free to maximize adherence. A uniform gradation of hard, durable aggregate will increase the resistance to impact from traffic and snowplows. Aggregate application needs to follow binder application very closely. The cover aggregate should be applied so it is only one layer thick. Excess aggregate increases the chance for dislodging properly embedded aggregate during the cleanup operation, as well as increasing the potential for vehicle damage. The aggregate may be gravel, crushed stone, or a mixture. Cubical shaped aggregate is preferable to flat aggregate. Flat and elongated aggregates can be susceptible to bleeding due to traffic causing the flat chips to lie on their flattest side. If flat aggregate is used and the binder is applied too thick, the pavement will bleed; if it is too thin, the pavement will ravel. Angular aggregate is preferable to round aggregate because angular aggregate chips tend to lock together.

One of the problems with seal coats is the generation of dust from the aggregate. One way to address the dust problem is to pre-coat the aggregate. Pre-coating involves applying either a film of paving grade asphalt or a specially formulated pre-coating bitumen to the aggregate. The use of pre-coated aggregate improves aggregate bonding properties, as well as reducing dust. It also shortens the required curing time and vehicle damage from loose aggregate. Fog seals may also be used to address dust problems and to cover the “gravel road” appearance of seal coat. Fog seals are generally a 50-50 mix of emulsion and water. It is important to recognize that skid resistance may be compromised with the use of fog seals.

Many design tools are available. One of the most often used is the Minnesota Seal Coat Handbook. It can be found at: http://www.lrrb.org/media/reports/200634.pdf. Another source is the Thin Maintenance Surfaces Manual developed by the Institute for Transportation at Iowa State University. It can be found at: http://www.intrans.iastate.edu/publications/_documents/handbooks-manuals/thin-maintenance-surfaces/thin_maint_surf.pdf.

C. Slurry Seal

Slurry seal is a mixture of emulsified asphalt oil, aggregates, water, and additives. It is pre-mixed and placed as a slurry onto the pavement. Slurry seals are commonly recommended for use on low and medium volume roadways. They are used to treat low to medium levels of raveling, oxidation, and rutting. Applications of slurry seals will improve skid resistance. Slurry seals are often described as the most economical, versatile TMS for low to medium volume roadways.

Aggregates commonly used for slurry seal applications consist of a combination of crushed stone and additives, such as Portland cement, lime, and aluminum sulfate. The additives are used to modify curing time. Aluminum sulfate retards curing time and Portland cement and lime shortens curing time. The aggregate gradations are described as fine and coarse. Coarse gradations have greater stability and are preferred for rut filling and scratch (bottom) courses. The additives make up less than 2% of the mixture and the aggregates are about 75% to 80%. Higher quality aggregates such as granite and quartzite will provide for a more durable application of slurry seal. Smaller aggregate gradations are used for maximum crack sealing, while coarse gradations are used when the project goal is to improve skid resistance.

The asphalt binder is an asphalt emulsion. The usual grades are CSS-1h or SS-1h, which are cationic and anionic slow setting emulsions, respectively. The emulsion is formulated with relatively stiff base asphalt (the suffix h = hard) for use in warm climates. The emulsion will make up about 7% to 14% of the mixture. Water is the remaining element of the mixture.

Temperature and humidity are critical to the cure time of the slurry seal. Temperatures must be 50°F and rising before application can begin. Slurry seals should not be placed at night. Slurry seals can be used to address slight rutting distress as well as to fill open joints by a strip treatment.

Mix design is generally completed by a laboratory certified by the International Slurry Seal Association (ISSA). Compatibility of the emulsion, aggregates, water mineral filler additives, and any other elements needs to be checked using materials that will be incorporated into the project.

D. Microsurfacing

Microsurfacing is a mixture of polymer-modified asphalt emulsion, graded aggregates, mineral filler, water, and other additives. It is mixed in a pug mill and evenly spread over the pavement. It is used to address oxidation, raveling, rutting, and skid resistance problems. Microsurfacing can be applied to higher speed, higher volume roadways than slurry seals and it can be used on both asphalt and concrete roadways. It can be placed at a thickness that is two or three times the size of the largest aggregate; however, trying to lay it too thick may result in rippling, displacement, and segregation. Multiple lifts are used if thicker application rates are needed.

Microsurfacing differs from slurry sealing in four main areas. They are:

- Microsurfacing can be placed in layers thicker than a single aggregate size.
- Microsurfacing always contains polymer modifiers.
- It cures through a chemical reaction versus evaporation.
- Higher quality aggregates are used.

Microsurfacing can also be accomplished at night to potentially minimize traffic impacts. If specifically designed for rapid opening, a microsurfacing project may be returned to traffic in as little as 1 hour.

Design of the microsurfacing mix is generally included in the contract to be completed by the contractor and/or the emulsion supplier. It is critical that all elements of the mix be compatible with each other in order to develop a mix that will address the project conditions. Publication A143 from the ISSA is used as a guide for development of the mix design.

Generally, a single emulsion that works for the climatic conditions and traffic volumes is selected. Cationic emulsions, such as CSS-1h, are typically used, but CQS-1h can be used if it is important to minimize traffic delays due to construction activities. Polymers are added to the emulsions to reduce thermal susceptibility, improve thermal crack resistance, and improve aggregate retention.

Aggregates must be high quality with fractured faces to form higher bonds with the emulsions. Freshly crushed aggregates, as opposed to weathered aggregates, have a higher electrical charge and improve the bond as well. Washing the aggregate to remove clay, silt, and dust is important to ensure proper cohesion.

Mineral fillers are used to aid in the mixing process and spreading of the mixture. Typical mineral fillers are Portland cement, hydrated lime, fly ash, kiln dust, limestone dust, and baghouse fines.

Additives may also be included in the mix. Aluminum sulfate, aluminum chloride, and borax are typically used. These additives allow the contractor to control breaking and curing times.

Properly designed and applied microsurfacing projects have a service life of up to 7 years.

E. Fog Seal

A fog seal is an application of diluted asphalt emulsion without a cover aggregate. It is used to seal and enrich the asphalt surface, seal minor cracks, and provide shoulder delineation. Fog seals are used on low and high volume roads. Its primary use on high volume roads has been to prevent raveling of open-graded friction courses in addition to delineating between the mainline and shoulder.

A fog seal is designed to coat, protect, and/or rejuvenate the existing asphalt binder. Fog seal use on mainline pavements should generally be restricted to only those locations having an open surface texture. This includes chip seals, heavily aged dense graded pavements, and open graded pavements. The fog seal emulsion must fill the voids in the surface of the pavement. A slow setting emulsion such as CSS-1 or SS-1, diluted to one part asphalt emulsion to four parts water is used. Emulsions that are not correctly diluted may not properly penetrate the surface voids and a slippery surface may be the result.

Before placing the fog seal, the pavement must be dry and clean and all pavement repairs accomplished. The diluted asphalt emulsion should be applied at 0.12 gallons per square yard. Success of application is impacted by temperature so summertime application is required. Generally, no application past August 31 is allowed. Pavement and air temperatures must be greater than 60°F to apply the fog seal.

The service life of a fog seal is fairly short, ranging from 1 to 2 years.