

Preventative Maintenance Treatment Type Selection

A. Introduction

Once all of the background, existing pavement condition, and future changes have been determined for a pavement section, the appropriate preventative maintenance treatment or treatments can be selected. Professional engineering judgment is critical in order to analyze the available data and select the most effective treatment. The selection of the most appropriate treatment must also take into consideration the availability of qualified contractors and the availability of quality materials to accomplish the work. In some instances, a combination of treatments may be needed to maintain the pavement in good condition.

In addition to the technical analysis, it is important to complete a financial review that will compare the various treatment types, their expected service life, and the associated costs. Comparisons can be made by calculating a simplified annualized cost through dividing the estimated cost of the treatment by the expected service life of each treatment type.

B. Flexible Pavement Treatment Types

Several traditional preventative maintenance treatments are available for flexible pavements. These include:

- Crack filling
- Crack sealing
- Full/partial depth patches
- Fog seals
- Slurry seals
- Microsurfacing
- Bituminous seal coats
- Milling
- Thin overlays

The above treatments will be described in greater detail. Additional treatments are available, but generally involve use of proprietary materials or processes or are not included in this manual. If appropriate, designers should include some of these other treatments in their analyses. These treatments are only effective if there are no structural problems with the pavement or the supporting subbase/subgrade.

1. **Crack Filling:** Crack filling is a good treatment method for reducing intrusion of moisture through the pavement slab. It will assist in reducing further crack deterioration, associated roughness, and rutting. Crack filling will traditionally involve minimal preparation and use of lower quality bituminous materials. Treatment should occur during cool, dry weather, which will provide for wider crack widths. Proper cleaning and a dry condition are the key to achieving good performance and maximizing service life. Cracks should be cleaned to a depth of 3 inches. Crack filling material is generally an asphalt emulsion since actually sealing of the crack is not

expected. Crack filling is appropriate for non-working cracks between 1/4 inch and 1 inch wide. The potential exists for increased roughness and loss of surface friction if the joint is overfilled. See [SUDAS Specifications Section 7040, 3.07](#). Service life is from 2 to 4 years.

- 2. Crack Sealing:** Crack sealing is effective at reducing moisture intrusion in the pavement as well as minimizing the amount of incompressible materials in the cracks. It differs from crack filling in that it is used on working cracks and involves crack routing, substantial crack preparation, and higher quality sealant material. Crack sealing is appropriate for cracks between 1/4 inch and 3/4 inch wide. Use on longitudinal or transverse cracks with little or no secondary cracking or raveling at the crack face. Proper crack preparation and cleaning are essential to optimal performance. Saw or rout cracks to a minimum 3/8 inch width and a depth of 1/2 inch. The width and depth may be adjusted depending on the sealant to be used. Clean cracks of existing joint filler material, vegetation, dirt, or other foreign material. See [SUDAS Specifications Section 7040, 3.06](#). Service life is from 2 to 8 years.
- 3. Full/Partial Depth Patches:** Patches restore a pavement's structural integrity and improve its ride. Partial depth patches address distress in the upper one-third of the pavement slab. Slab removal may be accomplished by sawing and jackhammer or by milling. Minimum partial patch depth is 2 inches and maximum depth is 1/2 of the slab thickness. Prior to placement of patch material, clean partial depth patch area and ensure it is dry. Cover entire patch area with tack coat. Lifts should not exceed 3 inches in thickness with the top lift 2 inches or less. Ensure the final compacted surface is level with or not more than 1/8 inch above the surrounding pavement. Full depth patches will address various types of more structural distress, such as broken down thermal cracks. Apply tack coat to all vertical edges. Maximum lift thickness is 3 inches with the top lift being 2 inches or less. Compact intermediate lifts with a roller or vibratory compactor, depending on patch size. Compact final lift with steel-wheeled finish roller. Ensure final compacted surface is level with or not more than 1/8 inch above the surrounding pavement. See [SUDAS Specifications Section 7040, 3.02](#) and [3.03](#). Patches are often completed in advance of a surface treatment. Service life is from 3 to 15 years.
- 4. Fog Seals:** Fog seals are applications of diluted emulsion without a cover aggregate and are used to seal the pavement, inhibit raveling, and slightly enrich hardened or oxidized asphalt. Application rates vary from 0.05 to 0.10 gallons per square yard. If necessary, vegetation control should be completed in advance of the treatment. Ensure pavement is clean and dry prior to application. See [Section 5I-4](#) for additional information. Fog seals can have a negative effect on friction and stripping in susceptible asphalts. Service life is from 1 to 3 years.
- 5. Slurry Seals:** Slurry seals are effective at sealing low-severity cracks, waterproofing the pavement, and restoring friction. Slurry seals also address raveling, oxidation, and hardening of asphalt. They are a mixture of crushed, well-graded aggregate, a mineral filler, and asphalt emulsion that is spread across the full width of the pavement or it can be used as a strip treatment for low areas and cracks. Thickness is generally less than 1/2 inch. The slurry is basically placed one aggregate layer thick. Allow a minimum of 7 days cure time before applying permanent pavement markings. See [Section 5I-4](#) and [SUDAS Specifications Section 7070](#). Service life is 3 to 6 years.
- 6. Microsurfacing:** Microsurfacing corrects or inhibits raveling and oxidation of the pavement, improves surface friction, reduces moisture infiltration, addresses low to medium severity bleeding, and can be used to fill surface irregularities and ruts up to 1 1/4 inch deep. Microsurfacing materials are similar to slurry seals except that microsurfacing uses latex modified asphalts versus an emulsified asphalt. Application of the microsurfacing is by specialized equipment using an augured screed. Microsurfacing typically breaks within a few

minutes of placement and can carry traffic after about an hour. See [Section 5I-4](#). Service life is 4 to 7 years.

7. **Bituminous Seals Coats:** Seal coats, also sometimes known as chip seals, are effective at improving surface friction, inhibiting raveling, correcting minor roughness and bleeding, and sealing the pavement surface. Bituminous seal coats are also used to address longitudinal, transverse, and block cracking, as well as sealing medium severity fatigue cracks. Seal coats can be applied in multiple layers to address more serious problems. Asphalt emulsion is applied directly to the pavement surface and is followed by the application of aggregate chips that are immediately rolled to embed them into the emulsion. Application rates depend upon the aggregate gradation and maximum size. Loose chips may be a problem on higher speed roadways. Fog seals may be used in conjunction with seal coats to provide a greater degree of binding for the aggregates. See [Section 5I-4](#) and [SUDAS Specifications Section 7060](#). Single layer service life is 4 to 6 years.
8. **Milling:** Milling is used to reduce pavement irregularities and to produce a uniform surface. Milling should be considered if rutting is at a level of 1/4 inch or more. Milling is used in conjunction with other surface treatments, such as slurry seals and microsurfacing in addition to thin asphalt overlays, and is not suggested to be used as a final stand-alone treatment. It can be used to restore proper grades and pavement cross-slopes. For best results, the milling depth should match the lift thickness of the exiting pavement. See [Section 5I-4](#) and [SUDAS Specifications Section 7040, 3.05](#).
9. **Thin Overlays:** Thin overlays are placed in a single lift less than 1 1/2 inches thick. The overlay is expected to improve rideability, surface friction, profile, crown, and cross slope. In addition, specific distress types of low severity cracking, raveling, roughness, low severity bleeding, and low severity block cracking are improved. Thin overlays dissipate heat rapidly and rely on timely compaction to be successful. Dense-graded, open-graded, and stone-matrix mixes may be used. See [SUDAS Specifications Section 7020](#). Service life is 7 to 10 years.

C. Rigid Pavement Treatment Types

Several preventative maintenance treatment types are available to address pavement distresses in PCC pavements. These include:

- Crack sealing
- Joint resealing
- Partial depth patches
- Full depth patches
- Dowel bar retrofit
- Diamond grinding
- Pavement undersealing/stabilization
- Pavement slab jacking
- Concrete overlays

These are the traditional preventative maintenance treatment types. Other less frequently used treatments are available to address specific distress needs.

1. **Crack Sealing:** Crack sealing is accomplished to reduce moisture intrusion and retard the rate of deterioration of the cracks. It is accomplished by thorough preparation and placement of high quality materials. It is used on random transverse and longitudinal cracks of low to medium severity where the crack width is less than 1/2 inch. Proper preparation of the crack and placement of the sealing material are critical for attainment of the expected 4 to 8 year service

life. The sealant material is critical to the success of the operation. Thermoplastic (rubberized asphalt) and thermosetting (silicone) sealants are the usual materials. The crack should be routed to 3/8 inch wide and 1/2 inch deep. The crack should be thoroughly cleaned and dried prior to application of the sealant. Refacing the sides of the crack with sandblasting is recommended. See [SUDAS Specifications Section 7040, 3.06](#).

- 2. Joint Resealing:** Joint resealing is important to minimize moisture in the joint and the subgrade/subbase, in addition to minimizing the intrusion of incompressible materials into the joint. Proper resealing of joints will reduce faulting, pumping, and spalling. Removal of the old sealant material and cleaning of the joint prior to resealing are critical. Removal of the old joint material can be accomplished by using a rectangular joint plow, diamond saw, or high-pressure water blast. Following refacing of the joint with a diamond bladed saw, the joint should be cleaned with high pressure air or water. Immediately prior to sealant application, the joint should be blown again with high pressure air to remove any sand, dust, or other incompressible that may remain in the joint. The joint must be dry and clean as joint sealant material is applied. See [SUDAS Specifications Section 7040, 3.06](#). Service life is 4 to 8 years.
- 3. Partial Depth Patches:** Partial depth patches are used to address spalling and surface scaling, as well as other problems in the top one-third of the pavement slab. Repair materials are selected based on available curing time, ambient temperature, size and depth of the repair, and cost. The materials are generally classified as cementitious, polymers, or bituminous. Rapid cure and high strength proprietary products are also available. It is critical to identify the limits of the weakened concrete so the patch can connect to sound concrete. The actual extent of the deterioration is often greater than what is visible at the surface. The removal area should extend a minimum of 3 inches beyond the deteriorated area in all directions. The patch area can be prepared by chipping with a lightweight jackhammer, milling with a carbon tipped milling machine, and sawing the edges of the patch and removal with a lightweight jackhammer. The patch area should be square or rectangular in shape and in line with existing joint patterns. The repair area must be swept, sandblasted, and air blasted to ensure a clean, dry patch area. Sandblasting is very effective at removing any dirt, oil, thin layers of unsound concrete, and laitance. Bonding agents are generally required for the patch materials. Sand-cements grouts consisting of one part sand and one part Type III cement with sufficient water to create a thick, creamy consistency have proven successful. Epoxy bonding agents can also be used with PCC and proprietary patching materials. Compressible joint materials must be used against the adjoining slab or to extend an existing joint through the patch area. The compressible material should extend 1 inch below and 3 inches beyond the repair boundaries. It may be possible to saw the joint through the patch, but timing is very critical. Since partial depth patches have large surface areas compared to their volume, it is very important to apply a curing compound as soon as the water has evaporated from the surface. The curing compound should be applied at 1.5 to 2 times the normal rate. The final step is resealing of the joint. See [SUDAS Specifications Section 7040, 3.03](#). Service life of a well done partial depth patch is 5 to 15 years.
- 4. Full Depth Patches:** Typical PCC pavement distresses that can be addressed by full depth repairs include transverse cracking, corner breaks, deteriorated joints, and blowups. Full depth repairs are an effective means for restoring the rideability and structural integrity of deteriorated PCC pavements. Long lasting full depth repairs are dependent upon selecting appropriate locations, effective load transfer design, and correct construction procedures, including finishing, texturing, and curing the patch. If the pavement exhibits a materials related deficiency, such as D-cracking, the service life of the patch will be short. Sizing the patch is critical to its success. Distressed areas should be identified and marked. Extent of the patch area may have to be adjusted if a period of time passes between initial identification and actual work activity. It may be necessary to do coring and deflection studies to identify the extent of deterioration below the slab surface. Full depth patches should be a minimum of 6 feet long and a full lane wide. All

joints through or adjacent to full depth patches must be re-established. Connect patches to make one large patch if the patches are 8 to 10 feet from each other in a single lane. The load transfer technique used in the patch should match the load transfer technique in the existing slab. Full depth repairs could be used in conjunction with diamond grinding to correct any roughness problems. [See SUDAS Specifications Section 7040, 3.02](#). Service life is expected to be from 10 to 15 years.

- 5. Dowel Bar Retrofit:** Dowel bar retrofit (DBR) is a method of load transfer restoration. It is used on non-doweled plain jointed concrete pavements. A successful dowel bar retrofit project will enhance pavement performance by reducing pumping, faulting, and corner breaks. Pavements with structurally adequate slab thickness, but exhibiting significant loss of load transfer due to poor aggregate interlock or base/subbase/subgrade erosion, are good candidates for DBR. It will also retard deterioration of transverse joints and cracks. Typical design includes three or four dowels inserted into the pavement at joints in each wheel path. The size of the dowel bar varies from 1 inch to 1 1/2 inches in diameter according to the slab thickness. See [SUDAS Figure 7010.101](#). The slots are generally 3 feet long, centered on the joint or crack. The slot must be long enough to allow the dowel to lie flat in the slot without hitting the curve of the saw cut. The width of the slot should be 2.5 inches and the depth sufficient to position the center of the dowel at the mid-depth of the slab. The slot must be parallel to the centerline of the pavement slab so the dowels do not lock up pavement movements. The dowel assembly will have end caps to facilitate movement and a compressible insert to form the joint across the slot. The slot filler materials are the critical element to a successful installation. Desirable properties include little or no shrinkage, similar coefficient of thermal expansion as the existing concrete, good bond strength, and the ability to gain strength rapidly. Concrete with Type III cement, sand, and 3/8 inch maximum sized aggregate can be used or there are proprietary products available. Dowel bar retrofit projects often include following up with diamond grinding. All transverse joints should be re-established by sawing over the joint and through the fill board. The joint should then be prepared and sealed. Dowel bar retrofit projects will allow the original service life of the pavement to be restored.
- 6. Diamond Grinding:** Diamond grinding is the removal of a thin layer of pavement surface using closely spaced diamond saw blades. It is used to improve ride quality by eliminating joint and crack faulting. In addition, surface friction, transverse cross slope, and tire/pavement noise are improved. It does not address structural problems or material related distress. Structural problems, such as pumping, corner breaks, and working transverse cracks, must be addressed before grinding. If joint/crack faulting exceeds 1/4 inch, the project may not be a candidate for diamond grinding. The blade spacing and width of groove are dependent on the hardness of the aggregate. As the aggregates get softer, the width of the land area and groove get larger. The depth of cut should be set so that 95% of the area is ground. The surface distresses will redevelop if the root cause of the distress is not corrected prior to diamond grinding. Thus, it may be necessary to complete full and partial depth patches, load transfer restoration, and slab stabilization prior to grinding. See [SUDAS Specifications Section 7040, 3.04](#). Service life varies from 5 to 15 years, depending on the hardness of the aggregates and the level of structural distress correction completed prior to grinding.
- 7. Pavement Undersealing/Stabilization:** Slab stabilization is pressure insertion of a flowable material to restore support beneath PCC slabs. It fills existing voids but does not lift the slab. Pavement stabilization restores pavement support, reduces pavement deflections, and reduces progression of pumping, faulting, and corner breaks. Slab stabilization must be completed prior to significant pavement damage. The main issue with slab stabilization is identifying where the voids are located and the extent of the voids. Distress surveys and deflection testing are necessary. Deflections may be measured using a FWD or by using a loaded truck with gauges placed at the corners of the slab. Other methods, such as ground penetrating radar or

thermography, are also available. Pozzolan-cement grout and polyurethane are the most common materials used for slab stabilization. Other proprietary products are available. It is important to only apply the material at locations where voids exist. If it is placed in areas without voids, the material can induce pressure points and actually increase the pavement deterioration. Once the area of the void is determined, the grout insertion holes can be drilled. Holes should be placed as far as possible from cracks and joints. Holes should be placed close enough to achieve flow from one insertion hole to another. Service life is from 5 to 10 years, depending on the level of truck traffic.

- 8. Pavement Slab Jacking:** Slab jacking consists of the pressure insertion of a grout or polyurethane material beneath the PCC slab as a means of raising the slab to a smoother profile. Slab jacking is normally used to correct localized settlement areas, such as over culverts or at bridge approaches. It should not be used to correct faulted joints. Grout insertion holes should be a minimum of 12 inches from a transverse joint or the edge of the slab. Holes should be spaced 6 feet or less center-to-center. It is critical to monitor the amount of lift performed at each location. The slab should not be lifted more than 1/4 inch at a time so that excessive stresses are prevented and slab cracking minimized. Uniform positioning of the grout holes is also important. Work should start from the lowest point of the section being raised and proceed out to the edges of the settled area in a repeating pattern. Materials for slab jacking are typically stiffer than those used for slab stabilization. Cement grout and polyurethanes are typically used.
- 9. Overlay:** Concrete overlays exist for all types of pavements, including concrete, asphalt, and composite. Thickness for preservation projects are generally between 3 to 4 inches. Similar to other concrete pavements, overlays require uniform support and effective management of movement. The overlay type can be bonded or unbonded. Bonded overlays are used to eliminate surface distresses when the existing pavement is in good structural conditions. Bonded overlays utilize the existing pavement as an integral part of the new monolithic system and thus thorough surface preparation is critical. Unbonded overlays are essentially a new pavement over a stabilized base (the old pavement). A bond breaker, such as a thin asphalt layer or a layer of non-woven geotextile, is needed between the existing pavement and the overlay. Typically, overlays are constructed using standard concrete mixes and standard construction techniques. Fibers may be added to the concrete mix for additional strength. Joints in bonded concrete overlays must match those in the existing pavement. Service life of concrete overlays is 15 to 20 years. Visit the National Concrete Pavement Technology Center's website (<https://cptechcenter.org/>) for more publications on concrete overlays.

D. References

Smith, K.D., T.E. Hoerner, D.G. Peshkin. *Concrete Pavement Preservation Workshop Reference Manual*. FHWA. National Concrete Pavement Technology Center/Center for Transportation Research and Education, Iowa State University. 2008.

Illinois Department of Transportation. *Bureau of Design & Environment Manual, Chapter 52 (Pavement Preservation)*. March 2012.

Transportation Research Board of the National Academies. *Transportation Research Circular, Maintenance Management 2009, Presentations from the 12th AASHTO-TRB Maintenance Management Conference*. E-C135. Annapolis, MD. July 2009.