

Utah Department of Transportation

# PAVEMENT PRESERVATION MANUAL – Part 3

## Preservation Treatments



Office of Asset Management

2009

# Forward

This manual is a part of a series of documents being prepared to compile information being used in our Pavement Management program. These documents will replace our 1998 Pavement Management and Pavement Design manual. Separate design manuals are being prepared to replace that section and provide guidance on the mechanistic design method.

Pavement Preservation Manuals:

Part 1 – Pavement Preservation and Rehabilitation Program

Part 2 – Pavement Condition Data

Part 3 – Preservation Treatments

Part 4 – Pavement Condition Modeling with dTIMS

Many factors influence the decisions being made on when and how to best maintain our pavements. The recent trend of increased costs and reduced funding has affected both the condition of our pavements and the strategic direction being used to manage these pavements.

Our pavements are aging, and are being subjected to continuously increasing levels of traffic. Our challenge as the stewards of our State's pavements is to select the right treatment at the right time, within our available funding limits, to maximize our pavement life. It has been well established that taking care of our pavements with well timed preservation treatments is more efficient than being in a reactive repair mode of maintenance or reconstruction.

In this context, "Preservation" will be understood to include routine maintenance, preventive maintenance, minor rehabilitation and some of the major rehabilitation treatments. UDOT has two funding programs for these preservation treatments, our Orange book program and our Purple book program. Our widening projects, major rehabilitation and capacity projects are funded with our Blue book program.

Much of the information in this manual has been taken from other States, the Federal Highway Administration, and our pavement Industry. This information has been taken and adjusted to meet our needs. The information is general in many places intentionally. With everything you ever needed to know about anything just a web page away, go surf the web for the details.

See our UDOT Pavement Management web page for additional information about our Pavement Management program.

See our UDOT Pavement Design and Materials Manuals for mix design and other material specifications.

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# Introduction

UDOT has two funding programs for our pavement preservation projects. Our Orange Book program has been set up to provide each Region with an annual allocation to fund selected routine maintenance and preventive treatments. Our more robust rehabilitation treatments can be funded with Purple Book program funds. This program will be funded similar to the Orange Book program and has been set up to make it easier to address projects that focus on the pavement without providing the typical full set of plans and going thru the complete STIP process.

Rehabilitation projects that need to include additional work beyond the pavement need to follow the typical process and compete with the rest of the widening and capacity construction projects for Blue Book funding.

## Typical Orange Book program work - Routine Maintenance & Preventive Treatments

### ASPHALT

- Crack Sealing
- Crack Filling
- Fog Sealing / Rejuvenation
- Chip Sealing
- Slurry Sealing
- Cape Sealing
- Scrub Sealing
- Pothole Patching
- Skin Patching
- Microsurfacing
- Ultra-Thin Bonded Wearing Course / Nova Chip Overlay
- Lane Leveling
- Rotomilling
- Thin Asphalt Overlay,  $\leq 1 \frac{1}{2}$ " Hot Mix Asphalt / Warm Mix Asphalt
- Thin Asphalt Overlay,  $\leq 1 \frac{1}{2}$ " Stone Matrix Asphalt
- Open Graded Seal Coat / Friction Course,  $\leq 1$ " Hot Mix Asphalt
- Milling with Thin Overlay

### CONCRETE

- Concrete Joint Sealing and Joint Spall Repair
- Diamond Grinding
- Slab Jacking
- Undersealing

## Typical Purple Book program work – Rehabilitation treatments

### ASPHALT

- Milling and Hot Mix Inlay / Overlay
- Heater Scarification / Hot In Place Recycle and Overlay
- Cold In Place Recycle and Overlay
- Milling and Thin or Ultra Thin Concrete Overlay
- Thick Asphalt Overlay,  $\geq 1 \frac{1}{2}$ " Hot Mix Asphalt / Warm Mix Asphalt

### CONCRETE

- Dowel Bar Retrofit
- Cross Stitching Longitudinal Joints or Cracks
- Partial or Full Depth Slab Repair
- Selective Slab Replacement
- Thin Bonded or Unbonded PCC Overlay
- Crack and Seat with Asphalt Overlay

Refer to our Materials web page for their numerous Technical Bulletins on emulsions, asphalts, etc. and their specific uses for many of these treatments.

# Asphalt Pavement Surface Treatments

## Crack Sealing

**Description:** Sealing cracks in asphalt pavements is one of the most effective methods of preventative maintenance. Crack sealing is typically performed on working cracks (movement equal to or more than 0.1 inch) and involves thorough crack preparation and placement of high-quality materials.

### Crack Filling:

Crack filling serves the same purposes as crack sealing but is less comprehensive. Preparation is typically limited to “blowing out” the cracks with compressed air. Crack filling is normally conducted on cracks that experience little movement (less than 0.1 inch) and are only slightly or moderately deteriorated.

### Full Depth Crack Repairs:

When cracks get excessive or too close together, often it is better to affect a full depth repair of the area rather than work on the individual crack. Usually when cracking is of this nature it is better to address the underlying problems causing the cracking as well as the effects.

**Purpose:** Correctly applied, and properly timed, the application of crack sealant material will help reduce moisture infiltration, retain material strength and reduce the potential for moisture-related distresses such as stripping, pumping of fines and accelerated fatigue cracking. Mostly used as a surface preparation for surface treatments.

**Pavement condition:** The condition of the existing bituminous surface depends upon the other Preventative Maintenance treatment the surface seal treatment will be combined with.

**Surface preparation:** Before sealing, the crack must be completely free of dirt, dust, and other materials that might prevent bonding of the sealant.

**Performance:** This treatment will help extend the service life of the treatment it is being used with and thus extend the service life of the pavement structure.

**Limitations:** Use caution in pavement selection if this treatment is to be used as a stand alone where there are too many cracks. Cold latex modified emulsion based sealants are suitable for smaller cracks with little movement. Fully cure emulsion based sealants before overlaying.

## Fog Sealing / Rejuvenation

**Description:** Fog sealing is spraying an existing pavement surface with a slow setting diluted asphalt emulsion, without an aggregate cover to seal the pavement surface or to bind the surface material into place reducing surface attrition. Rejuvenators are also a spray applied emulsion designed to penetrate the surface to modify and improve the chemical and rheological properties.

**Purpose:** The purpose of rejuvenation is to renew old asphalt surfaces. As a pavement ages its components undergo a variety of chemical and physical changes. Pavement will undergo oxidation of its asphalt binder, making the pavement brittle and susceptible to cracking and raveling. Rejuvenator products are typically used more on dense graded surfaces.

Fog seals are used to seal small cracks and surface voids, address raveling of chip seals and open graded surfaces on high volume roads, and to maintain and delineate shoulders on high volume roads.

**Pavement condition:** The existing pavement surface must be sufficiently porous to absorb a substantial amount of the rejuvenating emulsion. For fog seals the pavement should display low to moderate weathering or raveling.

**Surface preparation:** The pavement needs to be thoroughly cleaned before applying the products and must be dry. Test a small area of the pavement with different application rates to determine the optimal application rate for the entire area. Use higher application rates for passing lanes and shoulders where the traffic is lighter than on travel lanes where the traffic is heavier.

**Performance:** The life of the treatment depends on the condition of the pavement when the treatment was placed, the amount applied, traffic, and the environmental conditions.

**Limitations:** Do not use rejuvenation on a pavement that has low skid resistance or where the asphalt is unstable as indicated by rutting or shoving. Apply rejuvenation very cautiously to interstate and high volume roads. These roads might not need rejuvenation in the travel lanes because of the heavy traffic. Rejuvenation of the shoulders on these roads is a good use of rejuvenators. Apply sand to blot wet spots.

### **Typical Sealers:**

SS-1h, CSS-1, CSS-1h, CRS-2Pd, MC-70

### **Typical Rejuvenators:**

Pass QB, CRF, ERA-1, Reclamite, GSB (B)

## Chip Sealing

**Description:** Chip sealing is the adhering of a layer of crushed aggregate to an existing roadway surface using a polymer modified asphalt emulsion. A single or double chip seal can be used. The emulsion is sprayed onto the surface, immediately followed by the chip spreader. The chips are then rolled after spread over the emulsion.

**Purpose:** Chip seals are one of the most cost effective ways to improve skid resistance. A chip seal will rejuvenate or retard the oxidation of the existing asphalt binder, seal fine surface cracks reducing the intrusion of water into the pavement structure, and will retard the raveling of aggregate from a weathered pavement surface.

**Pavement condition:** The existing pavement exhibits a good cross section and a good base. The visible surface distress may include slight raveling and surface wear, longitudinal and transverse cracks with a minor amount of secondary cracking and slight raveling along the crack face, first signs of block cracking, slight to moderate flushing or polishing and/or an occasional patch in good condition.

**Surface preparation:** Seal all visible cracks and construction joints for single chip seals. It may be more economical and practical to place a double chip seal in lieu of a single chip seal when the number of cracks to be sealed reach a certain quantity and eliminate the sealing of the cracks.

**Performance:** The life expectancy of a polymer modified single chip seal is five to seven years. Double chip seals are reported to give about twice the service life as a single chip seal. This is with the assumption that both applications were placed on pavements in like condition. Since the double chip seals are used in lieu of crack sealing, the life expectancy may not be twice that of a single chip seal.

**Limitations:** Do not place chip seals on a plant mix seal coat. The construction season for this work is relatively short. Do not place chip seals if the temperature is below 65 degrees. It usually requires about one month of warm weather following construction for the aggregate particles to become reoriented and properly embedded in the asphalt membrane. Loose aggregate not embedded in the asphalt membrane will become airborne and possibly damage windshields of vehicles of the traveling public. Traffic noise will also increase after a chip seal is placed.

## Slurry Sealing

**Description:** Slurry seal is a mixture of asphalt emulsion, well-graded fine aggregate (sand, 1/8" size) and mineral filler mixed with water to produce a slurry consistency. Additives are often used to aid setting the slurry. Types of slurry seal are specified by the size of the aggregate used. The slurry is mixed in a self propelled pug mill and uniformly applied through a spreader box.

**Purpose:** Slurry sealing will seal minor surface cracks and voids, retard surface raveling, improve surface friction characteristics, and delineate different pavement surface areas.

**Pavement condition:** The existing pavement must not have large cracks that move under traffic. The existing pavement has to be stable with no excessive rutting or shoving. The treatment is too thin to correct surface profile or rutting.

**Surface preparation:** Crack sealing and patching must be done enough in advance of the slurry seal to allow for complete curing. Clean the pavement with a power broom immediately prior to construction of the slurry seal. Use a tack coat on dry or raveled pavements.

**Performance:** The life expectancy of a slurry seal is three to five years.

**Limitations:** Do not apply slurry seal on a pavement where the cracks move under traffic. Slurry seals require longer curing time than chip seals. Do not place during rain or if rain is expected before the slurry is set. Do not place at night, or if the temperature will drop below 45 degrees.

## Cape Sealing

**Description:** Cape seals are a combination of a chip seal covered with a slurry seal or a micro-surface. The idea behind this treatment is to provide a smoother surface than a chip seal can by itself.

**Purpose:** The slurry seal portion also fills in the space between the chip seal aggregate providing additional stability to the chip seal aggregate and giving a thicker membrane. This process prevents water intrusion into the subsurface better than either process alone.

Allow the chip seal to cure under traffic for a week or more prior to placing the slurry mixture.

## Scrub Sealing

**Description:** Scrub sealing is a membrane of polymer modified asphalt emulsion sprayed and then scrubbed into a cracked and aged surface with a broom. Additives such as portland cement, hydrated lime, or aluminum sulfate liquids are often used to aid setting the slurry. Then a layer of chips or sand is applied and broomed once again. The seal is then rolled with a pneumatic tire roller.

**Purpose:** Sometimes pavements are so old and aged that crack sealing is not an option. Scrub sealing is like an overall crack seal.

**Pavement condition:** The existing pavement must not have large cracks that move under traffic. The existing pavement has to be stable with no excessive rutting or shoving.

**Surface preparation:** Clean the pavement with a power broom immediately prior to construction of the scrub seal.

**Performance:** The life expectancy of a scrub seal is three to five years.

**Limitations:** Do not apply scrub seal on a pavement where the cracks move under traffic. Scrub seals require longer curing time than chip seals, about two hours. Do not place during rain or if rain is expected before the slurry is set.

## Localized Failure Treatments

### Pothole Patching:

Potholes are a danger to the travelling public and can lead to serious accidents and injuries. If left unattended, potholes will enlarge and cause the degrading of more of the road surface. Pothole patching includes repairing sewer cuts, utility cuts, crevices, surface subsidence, sinks and dips as well as potholes.

### Skin Patching:

Skin patching or blade patching is used to repair a full lane width of deteriorated surface.

## Microsurfacing

**Description:** Microsurfacing is a slurry seal mixture of polymer modified asphalt emulsion, high quality dense-graded aggregate and mineral filler mixed with water to produce a slurry consistency. Additives are often used to aid setting the slurry. Types of micro-seal are specified by the size of the aggregate used. The slurry is mixed in a self propelled specialized pug mill and uniformly applied through a spreader box.

**Purpose:** Used to retard raveling and oxidation, improve surface friction, reduce intrusion of water, and fill surface irregularities. Asphalt roads are susceptible to rutting which often requires milling the road then overlaying, which is expensive. A less expensive alternative is to fill the ruts with microsurfacing to restore the original pavement profile. With the polymers and other additives the seal can be placed thicker than a traditional slurry seal. This provides all of the benefits of a slurry seal with the additional benefits of being able to fill any ruts and improve the surface profile. Thicker applications should be done with multiple layers with a cure interval in between applications.

**Pavement condition:** The existing pavement has to be stable with a good base. The surface can include slight to moderate cracking, rutting, minor surface irregularities, flushed or polished surface and/or severe raveling. The existing pavement must not have large cracks that move under traffic.

**Surface preparation:** Crack sealing and patching must be done enough in advance of the microsurfacing to allow for complete curing. Clean the pavement with a power broom immediately prior to construction of the slurry seal. Use a tack coat on dry or raveled pavements. Existing striping should be removed.

**Performance:** Performs well on high volume roads. The life expectancy of microsurfacing is six to eight years. Microsurfacing is a poor crack sealer due the stiffness of the mix, and cracks will reflect through in a few months.

**Limitations:** Do not apply on a pavement where the cracks move under traffic. Microsurface mixes are very aggregate specific because of the chemically triggered quick reaction characteristics of the mixture. Requires special equipment and experienced contractors. Do not place during rain or if rain is expected before the slurry is set. Do not place if the temperature will drop below 45 degrees. Requires multiple lifts if placed on a milled surface.

## **NovaChip Overlay / Ultra-thin Bonded Wearing Course**

**Description:** The Nova Chip process is relatively new to the U.S. A layer of heavily-modified emulsion is applied to the surface “Novabond”, and within a few seconds, a layer of hot-mix asphalt (open graded 3/8” to 3/4” mix) is screeded onto the emulsion. In this instant, the water driven from the emulsion cools the hot-mix, setting both materials and providing a bond to the underlying surface. This type of overlay requires a special paving machine to hold and apply the emulsion and HMA in a single pass. The thin hot-mix is then rolled.

**Purpose:** A NovaChip overlay provides the same driving characteristics as an Open Graded Friction Course, but is a better sealant, and adheres better to certain surfaces. It prevents further decay and provides a new wearing surface but does not provide any structural improvement. Placement is quick in one pass and traffic can be returned within one half hour.

### **Pavement condition:**

Nova Chip can be considered for areas exhibiting:

- Structurally sound pavement
- Low severity rutting
- Low to medium severity transverse, longitudinal or block cracking
- Low to medium severity bleeding
- Low to medium severity edge cracking
- Low severity patching
- Low to high severity raveling and weathering
- Low to medium severity block cracking

Nova Chip should not be considered for areas exhibiting:

- Structurally failed pavement
- Alligator cracking
- Medium to high severity rutting
- High severity transverse, longitudinal or block cracking
- High severity bleeding
- High severity edge cracking
- Medium to high severity patching
- Potholes
- Delamination (unless patched)

**Surface preparation:** If the pavement is rough, milling or adding a leveling course is recommended. Mill or level any ruts. Fill existing cracks flush with the surface.

**Performance:** Performs well on high volume roads. The life expectancy of a bonded wearing course is seven to ten years.

**Limitations:** Do not apply on a pavement where the cracks move under traffic. Can be placed on a milled surface. Requires special equipment and experienced contractors. Do not place if the temperature will drop below 45 degrees.

## Lane Leveling

**Description:** Lane leveling is an application of a course of hot-mix asphalt.

**Purpose:** Lane leveling is used to restore the profile and cross section to the surface. This treatment is then followed with an overlay.

**Pavement condition:** The existing pavement has a deficient profile and cross section.

**Surface preparation:** Clean the pavement with a power broom immediately prior to construction.

**Performance:** A lane leveling will not last very long if no overlay is placed over it. The mix is a finer gradation and placed in thin lifts, so the quality of the pavement is not as robust as a coarser gradation placed with a laydown machine. The performance is very dependant on the mix, how well it's compacted, the condition of the existing pavement, and the expected traffic.

**Limitations:** Not a good application for heavy traffic. Not a good application for rutting due to stripping

## **Rotomilling**

**Description:** The removal of an existing asphalt surface by cold milling. This treatment is then followed with an overlay.

**Purpose:** The cold milling is used to remove an old open grade surface course, or other surface layers. Also use to remove rutting when not caused by weak base, and the pavement has deteriorated to a point where it is not practical to correct the rutting with a more economical treatment. Use to remove surface courses that are delaminating. Use to correct deficient crown or super elevation sections. Use to correct isolated deficiencies in one lane, while leaving the existing pavement in the other lanes. Use to maintain elevations along curb and gutter sections. Use to maintain clearances under structures.

**Pavement condition:** Core the exiting pavement to ensure the depth of milling does not expose a weak layer or result in the thickness of the existing pavement being less than desired.

**Surface preparation:** Lower manholes.

**Performance:** NA

**Limitations:** Have a plan for what to do with the milled material.

## Thin Asphalt Overlay – Hot Mix / Stone Matrix

**Description:** A thin asphalt overlay is limited to 1.5 inches. Hot mix asphalt (HMA) is the most common. Stone Matrix Asphalt (SMA) is also being used.

**Purpose:** A thin asphalt overlay is the highest type of fix available. These are used to protect the pavement structure, slow the rate of deterioration, correct many surface deficiencies, improve the ride quality, and add a minor amount of structural enhancement to the existing pavement.

**Pavement condition:** The existing pavement exhibits a good base condition and a uniform cross section. The visible surface distress may include moderate to severe raveling, longitudinal and transverse cracks with the first signs of raveling and secondary cracking, first signs of edge cracking, block cracking, extensive to severe bleeding or polishing, some patching in good condition or any of the above. The pavement may also have some minor base failures and depressions.

**Surface preparation:** Limit this preparation work to the repair of any minor base failures and depressions, the filling of voids in the surface, the removal of any patched areas with a very high asphalt content that may bleed up through the new surface, the correction of any tented joints and the correction of deficient superelevation, if required.

**Performance:** This fix is preferred for higher volume roads. The life expectancy of a thin overlay is seven to ten years.

**Limitations:** Don't place a thin asphalt overlay on a rutted pavement, a pavement with a weak base, or a delaminated surface. If placed on a concrete pavement expect reflective cracking. The existing pavement should be cored to evaluate its condition.

### HMA Mix Types:

- **Dense-Graded Mixes**  
A dense-graded mix is a well-graded HMA intended for general use. Generally referred to by their nominal maximum aggregate size, 1/2" or 3/4 ". Suitable for all pavement layers and traffic conditions. Works well for structural, friction, leveling and patching needs.
- **Stone Matrix Asphalt (SMA)**  
A stone matrix mix is a gap-graded mix designed for stone on stone contact specifically to resist rutting and maximize durability. Used for surface courses on higher volume roads.
- **Open-Graded Mixes**  
Open-graded mixes are designed to be water permeable with a high percent of air voids. Used for surface courses only. Typically smoother and quieter than dense-graded HMA.

## **Open Graded Seal Coat / Open Graded Friction Course**

**Description:** An Open Graded Seal Coat (OGSC) is an open graded hot mix asphalt surface course limited to 1 inch of thickness. Open-graded mixes are designed to be water permeable with a high percent of air voids. Limited surface sealing is provided by the tack coat applied under the mix.

**Purpose:** An OGSC is used to improve the ride quality and skid resistance. The surface provides reduced spray from water on the road, and a quieter riding surface.

**Pavement condition:** The existing pavement has to be stable with a good base and less than 1/2" rutting. The surface can include slight to moderate cracking, minor surface irregularities, flushed or polished surface and/or severe raveling. The existing pavement must not have large cracks that move under traffic.

**Surface preparation:** If the pavement is rough, milling or adding a leveling course is recommended. Mill or level any ruts. Fill existing cracks flush with the surface.

**Performance:** Performs well on high volume roads. The life expectancy of an open graded seal is eight to twelve years, however we've seen many fail sooner. The only repair for a failed open graded seal is to remove it.

**Limitations:** No more than two OGSC layers can be placed before the OGSC needs to be removed. It is unstable due to gap grading and is also susceptible to stripping if it is overlaid or chip sealed. Crack sealing and patching can be a problem. Sealed cracks and patches at the edge of the pavement can create a dam in the surface that inhibits the flow of water. As a result, the surface can become saturated, which can lead to stripping. Deicing salt requirements are increased because the salt penetrates into the pavement surface. Freezing of moisture in the surface can develop excessive stresses and promote fracture. Over time the drainage ability may decrease due to the clogging of the voids with dust and the application of winter deicing chemicals and abrasions.

## **Asphalt Pavements - Rehabilitation Treatments**

These are some typical treatments that can be classified as either minor or major rehabilitation. This is a vague distinction, but for definition purposes if additional pavement structure is added it becomes a major rehabilitation. It comes down to how thick the asphalt overlay is. If it's more than 1.5" over the existing thickness, it becomes a structural overlay and falls into the major rehabilitation list.

### **Milling and Hot Mix Inlay/Overlay**

Often a road can not be overlaid because its surface is rough or badly oxidized. In this case the surface of the road needs to be prepared before new pavement can be applied. The poor quality or rough asphalt is cold planed off using a milling machine in preparation for the new layer of hot-mix asphalt. Sometimes milling is to keep the same profile adjacent to curb and gutter.

### **Heater Scarification and Overlay**

Heater Scarification and Overlay, also referred to as Hot In Place Recycling (HIR), is an effective pavement preservation treatment to improve the functional performance of an existing pavement. Totally repaving an existing surface may not be necessary if the pavement is structurally adequate and has a stable base. During the heating and scarifying process, the top one to two inches of an existing pavement is heated and milled off, combined with recycling agent and sometimes additional fresh aggregate on site, then the reworked material is replaced and compacted and overlaid with hot-mix asphalt. Pavement structure can be improved depending on how thick the overlay is.

### **Cold In Place (CIP) Recycle & Overlay**

Cold In Place Recycle & Overlay is the removal of the top two to four inches of an existing pavement, combining that material with recycling agent and sometimes fresh aggregate on site, replacing and compacting the reworked material and overlaying it with hot-mix asphalt. Sometimes the surface is milled and removed first, to recycle a deeper layer – or to maintain the existing surface elevation after the overlay.

### **White Topping on Asphalt**

White Topping on Asphalt, sometimes referred to as a Thin PCC Overlay or Ultra-Thin White Topping, is a pavement preservation technique wherein the surface of an existing asphalt pavement is cold milled to enhance the bond between the existing pavement and a ultra thin (2 to 4 inch) or thin (6 inch) Portland Cement Concrete (PCC) overlay. White topping overlays are sawed into short slabs, typically between 4 and 6 feet square to help reduce bending and thermal stresses. Ultra thin overlays are typically limited to intersections.

### **Thick Asphalt Overlay / Structural Overlay**

A hot mix asphalt overlay over 2 inches thick used to increase the pavement structure.

# Concrete Pavement Surface Treatments

## Concrete Joint Sealing and Joint Spall Repair

**Description:** This work includes the removal of the existing seals, the repair of the pavement spalls at the joint to restore the shape of the joint, and the resealing of the joint.

**Purpose:** Keeping the joints sealed prevents water and other incompressible material from entering the pavement structure, thus slowing the deterioration of the concrete pavement.

**Pavement condition:** The existing joint sealant must be deteriorated or missing.

**Surface preparation:** Before resealing, the old sealant must be removed. At the time of sealing, the joint must be clean and completely free of moisture and any other material that might prevent the bonding of the sealant. Spalled edges must be completely squared up and all deteriorated concrete removed prior to placing repair material. The surface must be clean, dry, and free of any material that may prevent the patch from bonding.

**Performance:** The life expectancy of seals is ten years. Spall repair should perform for the life of the pavement.

**Limitations:** Sealing joints will not be effective if the existing pavement is badly deteriorated.

## Diamond Grinding

**Description:** Diamond grinding is the removal of the top surface of the pavement with closely spaced diamond tipped saw blades. The grinding process is wet and water supply trucks and waste removal trucks are a part of this. Several passes are required to grind the full lane width.

**Purpose:** Diamond grinding is used to restore the profile and cross section of the pavement surface and improve the ride quality. Grinding removes the joint faulting, removes minor wheel path rutting, removes the polished or lightly scaled surface, improves skid resistance and reduces traffic noise. Grinding can be used to improve drainage deficiencies.

**Pavement condition:** The existing pavement should have a uniform cross section and a sound base. The surface distress may include joint faulting, wheel path rutting, minor slab warping at the joints, polishing, and light scaling. Consider grinding when the international ride index (IRI) is over 140 or average skid numbers are 30 or less.

**Surface preparation:** Complete all joint and slab repair work before grinding.

**Performance:** Faulting at the joints may return after several years depending on traffic and how well the joints perform. The improvement to surface friction will depend on the final micro and macro texture. The improved skid values will decline over time to the original values. The time this takes will depend on the aggregate hardness and polishing characteristics, as well how well the grinding texture performs. Diamond grinding will not add any life to the pavement, but will improve the serviceability and slow the rate of deterioration.

**Limitations:** It is important that at least 95 % of the surface is grinded. If there are low spots not getting ground, another pass should be made. Do not use diamond grinding as a one step solution to treating the deficiencies of the pavement, the underlying causes of the deficiencies are still there.

## **Slab Jacking or Undersealing**

**Description:** Undersealing is filling the voids under the concrete slab with a material such as cement grout or high density polyurethane under pressure through holes drilled in the slab. Slab jacking is carefully overfilling the voids to lift the concrete slab.

**Purpose:** The purpose of filling the voids is to reestablish a stable base to support the slab to prevent faulting or cracking. It is also done to prevent the material under the slab from pumping out from under the slab when moisture is present. The purpose of slab jacking is to restore the pavement profile and or cross section.

**Pavement condition:** There could be movement of the slab at the joints or cracks. Pumping can be identified by staining on the surface. The existing slabs will be faulted and there may be cracking where there is a loss of support.

**Surface preparation:** None.

**Performance:** Undersealing provides continuous support under the slab which in turn increases the structural integrity of the pavement section and extends its performance life. Undersealing or slab jacking will not restore the joint load transfer efficiency.

**Limitations:** Slab jacking and Undersealing require considerable experience, trained personnel, and special equipment. Often ineffective if used alone without restoring the joint load transfer and diamond grinding to restore the ride quality.

## **Concrete Pavements – Rehabilitation Treatments**

### **Dowel Bar Retrofit**

Many of our concrete pavements were built without dowel bars. As the load transfer across the transverse joints break down the pavement starts to develop joint faulting, and provides a poor ride quality. Treatment is appropriate when the slabs are still in good condition, and the load transfer efficiency has dropped below 70%.

The retrofit involves saw cutting and then removing the material between the cuts to create slots for the dowel bars. Typically three are placed in each wheel path, across every transverse joint or crack. Epoxy coated bars are placed in the cleaned out slots, and then the slots are filled with non shrink grout. Finally the patched area is diamond ground, and the joint reestablished with a saw cut.

### **Partial or Full Depth Slab Repair**

Partial depth repair is used to repair joint spalling or other surface distresses that don't extend beyond the top third of the slab. Use a full depth repair for corner breaks or severe joint deterioration. Saw cut around the effected area and remove all unsound concrete. For full depth repairs compact the base, and reestablish load transfer and joints with adjacent panels. Full depth repairs are usually for the full lane width. Full depth repairs should be wide enough to allow room for drilling dowel bar holes.

If the area needing to be repaired is small enough, full depth repairs can be made with the large coring drill very efficiently.

### **Selective Slab Replacement**

Replace the entire panel for shattered slabs, or when the full depth slab repair would be more than half a panel. Don't damage the adjacent panels while removing the broken panel. Compact the base, and reestablish load transfer and joints with adjacent panels.

### **Thin Bonded or Unbonded Concrete Overlay**

Thin bonded overlays are typically less than five inches thick, and used to add additional structure to an existing concrete pavement in good condition due to additional traffic demands. Any broken slabs or other defects need to be repaired before the overlay is applied. The existing surface should be ground and thoroughly cleaned to ensure a complete bond. All joints and cracks in the underlying pavement will reflect through in a very short time so carefully locate saw cuts.

Unbonded overlays are thicker than five inches and are placed on an asphalt layer.

## Appendix A

### Treatment Costs

Average treatment costs have been calculated from recent bid prices. Unit costs are for typical paving items associated with the treatment. Project unit costs are also included. These are the unit prices used with our modeling.

Project costs include additional pay items typically included in projects. Mobilization, traffic control and striping are typical for surface seal jobs. More involved treatments typically include work for adjusting utilities, curb gutter sidewalk and driveway adjustments, signs, guard rail, drainage etc.

<u>Treatment</u>	<u>Unit Costs</u>	<u>Project Costs</u>
Crack Sealing		
Crack Filling		
Fog Sealing / Rejuvenation		
Chip Sealing		
Slurry Sealing		
Cape Sealing		
Scrub Sealing		
Pothole Patching		
Skin Patching		
Microsurfacing		
Ultra-Thin Bonded Wearing Course / Nova Chip Overlay		
Lane Leveling		
Rotomilling		
Thin Asphalt Overlay, $\leq 1 \frac{1}{2}$ " Hot Mix Asphalt / Warm Mix		
Thin Asphalt Overlay, $\leq 1 \frac{1}{2}$ " Stone Matrix Asphalt		
Open Graded Seal Coat / Friction Course, $\leq 1$ " Hot Mix Asphalt		
Concrete Joint Sealing and Joint Spall Repair		
Diamond Grinding		
Slab Jacking		
Undersealing		
Milling and Hot Mix Inlay / Overlay		
Heater Scarification / Hot In Place Recycle and Overlay		
Cold In Place Recycle and Overlay		
Milling and Thin or Ultra Thin Concrete Overlay		
Thick Asphalt Overlay, $\geq 1 \frac{1}{2}$ " Hot Mix Asphalt / Warm Mix		
Dowel Bar Retrofit		
Cross Stitching Longitudinal Joints or Cracks		
Partial or Full Depth Slab Repair		
Selective Slab Replacement		
Thin Bonded or Unbonded PCC Overlay		
Crack and Seat with Asphalt Overlay		

## Appendix B

### Pavement Life Strategy

UDOT has developed the following strategies to preserve and maximize the service life of our pavements. If we had sufficient funding, these time-based treatments are what would be done.

UDOT pavements are divided into the following Pavement Families:

Interstate Concrete

Level 1 Concrete: all other concrete

Interstate Asphalt

Level 1 Asphalt: AADT > 2,000

Level 2 Asphalt: AADT < 2,000

Gravel

These categories are slightly flexible and have been set to establish different performance criteria. Our Interstate pavements carry the highest traffic volumes, highest freight movements, at the highest speeds. These are clearly our highest priority pavements and have the highest performance goals for smoothness and overall condition. At the other end of our performance spectrum are our lower volume Level 2 pavements. These are generally older pavements, have more environmental distress, and have lower performance goals for smoothness and overall condition.

The following treatment strategies are guidelines for planning design life treatments and estimating life cycle costs. These will be listed in general categories. The starting point for each cycle will be initial construction or new pavement. Actual treatments and timing will be based on actual condition, available funding, and statewide priorities.

Interstate Concrete – 10 year treatment cycle

Preservation: Grinding and Joint Repair.....	Year 10
Minor Rehabilitation: Partial and Full Depth Slab Repairs.....	Year 20
Preservation: Grinding and Joint Repair.....	Year 30
Major Rehabilitation / Reconstruction.....	Year 40

Level 1 Concrete – 12 year treatment cycle

Preservation: Grinding and Joint Repair.....	Year 12
Minor Rehabilitation: Partial and Full Depth Slab Repairs.....	Year 24
Preservation: Grinding and Joint Repair.....	Year 36
Major Rehabilitation / Reconstruction.....	Year 48

Interstate Asphalt – 6 year treatment cycle

Preservation: Surface Seal.....	Year 6
Preservation: Surface Seal.....	Year 12
Minor Rehabilitation: Recycle and Thin Overlay.....	Year 18
Preservation: Surface Seal.....	Year 24
Preservation: Surface Seal.....	Year 30
Major Rehabilitation: Structural Overlay.....	Year 36

Level 1 Asphalt – 8 year treatment cycle

Preservation: Surface Seal.....	Year 8
Preservation: Surface Seal.....	Year 16
Minor Rehabilitation: Recycle and Thin Overlay.....	Year 24
Preservation: Surface Seal.....	Year 30
Preservation: Surface Seal.....	Year 38
Major Rehabilitation: Structural Overlay.....	Year 44

Level 2 Asphalt – 10 year treatment cycle

Preservation: Surface Seal.....	Year 10
Preservation: Surface Seal.....	Year 20
Minor Rehabilitation: Recycle and Thin Overlay.....	Year 30
Preservation: Surface Seal.....	Year 40
Preservation: Surface Seal.....	Year 50
Major Rehabilitation: Structural Overlay.....	Year 60