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ASSESSMENT OF SURFACE TREATMENT WITH TEXTILES FOR PAVEMENT REHABILITATION AND MAINTENANCE

by

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ABSTRACT

Pavement preservation toolboxes typically consist of several surface treatments that can be considered to preserve or extend the life of a pavement – possible surface treatments include chip sealing or thin lift overlays.

Although paving fabrics are normally used with asphalt concrete overlays, paving fabrics are also found to be cost-effective when used in conjunction with a chip seal. Documented life cycle cost studies find that paving fabrics can extend the life of a chip seal by an additional 50 to 75 percent in the warm climate areas of California and Texas.

The paving fabric industry has been challenged by the Federal Highway Administration and other pavement preservation practitioners to develop a reasonable approach for chip sealing over paving fabric in various climatic conditions throughout the United States, in addition to those successfully done in the warm areas of California and Texas.

Respecting this challenge, 33 projects were installed in seven temperature zones throughout the United States including Colorado, Illinois, Michigan, Minnesota and Washington DC, and other parts of California and Texas. Field experiments were placed in cooperation with cities, counties, state and federal highway transportation departments, with contributions from chip seal contractors, fabric installers and fabric manufacturers.

The objective of this paper is to quantify the climatic areas where chip sealing over paving fabric can be done successfully and provide a cost-effective contribution to pavement maintenance and preservation. In addition, information will also be provided on its economic and environmental benefits, and construction materials application depending on climatic condition.

INTRODUCTION

It is common knowledge that cracks appear in asphalt concrete pavements for a number of reasons. However, when a road is resurfaced with hot mix asphalt concrete, it is expected the cracks in the underlying pavement surface will reflect through the new asphalt concrete surface. When this occurs, surface water is allowed to migrate through the pavement and enter into the roadway's base and subgrade which is detrimental to the roadway's structural section. In order to prevent cracks from reappearing on the pavement surface and allowing surface water to penetrate, practitioners require the placement of paving fabric interlayers during the asphalt concrete resurfacing operation – this practice is common and has been done in the United States of America for decades.

Another method of pavement preservation is applying a chip seal surface treatment. The purpose of a chip seal is to seal an asphalt concrete surface on roadways that have sound structural sections; other benefits are providing an all-weather surface course, increased friction, prevent raveling and water penetration into the existing asphalt concrete surface all which result in extending the life of the roadway. Chip seals have been used throughout the United States, and the world, for over a century.

For over 25 years, pavement preservation practitioners have combined both processes and created an improved chip seal process by incorporating the placement of a paving fabric interlayer immediately prior to placing the chip seal. This practice combines the benefits realized from chip sealing and from placing a paving fabric interlayer with hot mix asphalt concrete resurfacing. This practice has been done successfully for over 25 years in Northern and Southern California, and Texas.

Because chip seals have temperature requirements that are more restrictive than those for placing a paving fabric with asphalt concrete resurfacing, the paving fabric industry has been challenged by the Federal Highway Administration (FHWA) and pavement preservation practitioners to develop a reasonable approach for the use of chip seals over paving fabrics in the various climatic conditions of the United States of America. Respecting this challenge, chip sealing over fabric projects have been installed in areas of varying climates throughout the United States including Colorado, Illinois, Michigan, Minnesota and Washington DC, as well as other parts of California and Texas.

This paper addresses a study which includes 33 installations of paving fabric under chip seals in seven temperature zones. Field experiments were conducted in cooperation with cities, counties and the FHWA with contributions from chip seal contractors, and fabric installers and manufacturers. Discussion will also be provided for best usage to poor usage as a result of these experiments.

DESCRIPTION

The paving fabric under chip seal surface treatment is constructed by placing a paving fabric on a properly prepared and structurally sound pavement, followed by a single chip seal (Figure 1) or a double chip seal (Dendurent, 2009).

Due to the thickness of the chip seal, proper installation of a paving fabric is slightly different and more critical than its placement prior to a hot mix asphalt overlay. Guidance on the proper installation of paving fabrics under a chip seal can be found in the recently published

Davis et al. paper (2008) and in installation guidelines published by major U.S. manufacturers of paving fabrics in Brown (2003) and Sprague et al. (1993).

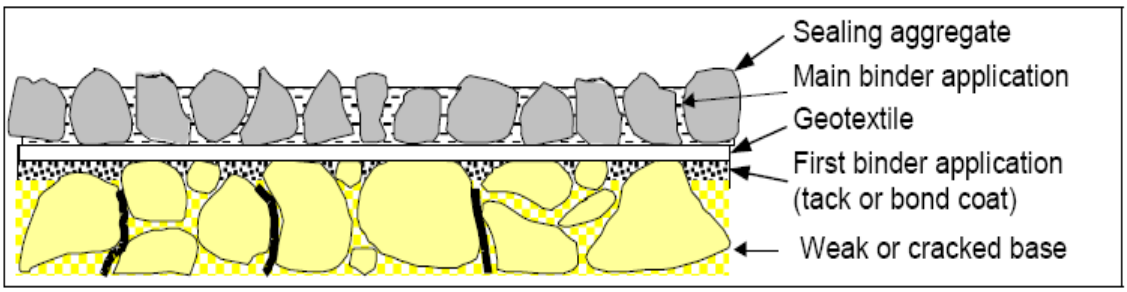

Figure 1. Paving Fabric Placed Under Single Chip Seal (Alderson, 2006)

BENEFITS OF COMBINING ROADWAY PRESERVATION METHODOLOGIES

Benefits of Chip Sealing

It is important for practitioners to understand that chip seals are a "surface treatment" and are not designed to increase the structural capability of the pavement, yet they do protect the structural integrity of a pavement which results in prolonging the life of the pavement. Therefore, the existing roadway must be structurally sound, isolated repairs completed (patched and cured), pavement surface clean and dry, and have the necessary temperatures (ambient and pavement) present to allow the chip seal emulsion to cure. The benefits of chip sealing are (California Chip Seal Association, 2009):

- Cost effective surface treatment
- Protects underlying pavement
- Waterproofs the pavement surface
- Seals small cracks and imperfections
- Provides surface wearing course
- Improves aesthetics and delineation, improves safety
- Extends service life

Benefits of Paving Fabric Interlayers

The greatest source of damaging a roadway's structural section is water infiltration through the pavement surface. Should a pavement base be saturated as little as 10 percent of the time, the useful life of that pavement will be reduced by 50 percent. Paving fabrics are saturated with a liquid asphalt tack coat which performs as a moisture barrier within the pavement. The paving fabric interlayer system becomes an integral part of the roadway structural section by forming a barrier to surface water infiltration and absorbing stresses to reduce reflective and fatigue cracking of the new asphalt concrete surface.

Paving fabric interlayer systems are recognized to extend the service life of asphalt concrete overlays. The life extension is attributed to both the stress-absorbing function, which can retard reflective cracking, and the waterproofing function, which protects the pavement structure (Paving Information Bulletin, 1976). In the waterproofing function, the paving fabric

can help maintain lower moisture content beneath the pavement by minimizing water infiltration through the pavement (Burmania, 1988; Marienfeld and Baker, 1999; Brown, 2000).

Maintaining a road's base materials at a lower level of moisture can result in maintaining the strength of these materials at higher levels. The relative contribution of the two functions depends on the pavement condition and the environment (Buttlar, et al., 1999).

In summary, the benefits of paving fabric interlayer systems are:

- Control reflective cracking
- Eliminate future crack filling
- Prevent surface water infiltration
- Stabilize subgrade moisture content
- Allow wet subgrades to regain strength and load carrying capacity
- Protect the underlying pavement from aging, oxidation and traffic wear

Benefits of Chip Sealing Over Paving Fabric

The County of San Diego, like many other public agencies, is always looking for cost-effective ways to maintain roads. Innovation and creativity are necessary because funding often does not increase from year to year even though roadway maintenance needs and costs continue to escalate (Davis, 2003).

Agencies and industry have become innovative by combining pavement preservation methodologies. Reason being, to look for more ways to maintain and preserve roadways and increase the number of surface treatments in their "pavement preservation toolbox" to extend the life of structurally sound roadways. Following are some examples of how agencies have accomplished this:

- Fog seal over a new chip seal
- Slurry seal over a new chip seal (often referred to as a cape seal)
- Asphalt concrete resurface over a paving fabric interlayer
- Apply double applications of a chip seal
- Chip seal over a paving fabric interlayer

Although the initial construction cost is greater than placing a single surface treatment, agencies are finding that the cost benefit is realized from doing a life cycle cost analysis; this is discussed in greater detail later in this paper.

Analyzing the Benefits of a Chip Seal Placed Over Paving Fabric

In 1987, the County of San Diego developed six test sections on Yaqui Pass Road (Borrego Springs) to evaluate the performance of several surface treatments. The goal was to find a treatment that retards reflective surface cracks under desert weather conditions, without performing any crack sealing in advance.

There were two experimental surface treatments that performed very well in addressing reflective surface cracks and sealing the roadway surface under desert conditions:

- Chip seal with latex modified emulsion over paving fabric
- Chip seal with ground rubber modified paving asphalt binder

The width of the underlying pavement's surface cracks determined which of the two surface treatments performed the best. The chip seal with ground rubber modified paving asphalt binder performed well as long as there were no wide surface cracks present in the

underlying pavement – if wide surface cracks were present, they reflected through to the surface of the new chip seal which required subsequent crack sealing to prevent the penetration of surface water into the pavement.

However, the chip seals that were placed over paving fabric performed very well, regardless of the width of the underlying pavement's surface cracks. The only negative impact noticed was chip loss was experienced in the new surface treatment in the area where wide surface cracks were present in the underlying pavement. Even when chip loss occurred, the asphalt saturated paving fabric continued to bridge across the cracks which prevented penetration of surface water into the underlying pavement, and eliminated the need for any subsequent crack sealing.

Current Practice in the United States of America

Placing paving fabric prior to a single-chip seal has been a standard surface treatment practiced by the County of San Diego for over 20 years (Dendurent, 2009). Northern California also reports successful applications of placing fabric prior to a double-chip seal (Brown, 2003). Research shows some fabric under chip seal projects in the United States have resulted in maintenance-free pavements that received this application over 20 years ago, with little to no reflective cracking (Dendurent, 2009). Photograph 1 reflects an example of a road that received a chip seal over paving fabric with no subsequent road maintenance to date.

Photograph 1. Aerojet Facility, Northern California
20-Year Old Double-Chip Seal over Paving Fabric

MATERIAL PROPERTIES AND APPLICATION RATES

Material Properties

Fabric

The requirements for pavement reinforcing fabric follows AASHTO Standard Specifications modified for chip seals. The fabric is manufactured from polyester or polypropylene material, nonwoven, heat-treated on one side, and conforms to the following (Table 1):

Table 1. Paving Fabric Properties

Mechanical Properties	ASTM Test Method	Unit	Minimum Average Roll Value	
			Machine Direction	Cross-Machine Direction
Grab Tensile Strength	D4632	pounds (kN)	102 (0.45)	102 (0.45)
Grab Tensile Elongation	D4632	%	50	50
Grab Tensile Asphalt Saturated	D4632	pounds (kN)	200 (0.89)	
Grab Tensile Elongation Asphalt Saturated	D4632	%	40 - 70	
Asphalt Retention	D6140	gal/yd^2 (l/m^2)	0.27 (1.2)	
Mass per unit area	D5261	oz/yd^2 (g/m^2)	4.1 (140)	

Fabric Binder

Practitioners in Northern California use liquid asphalt grade PG 64-22 or PG 67-22 as a fabric binder; selection is based on the highest ambient temperatures experienced throughout the year. Liquid asphalt binders for other areas should be used in accordance with the area's state specifications for asphalt production. The most common asphalt used for paving fabric binder is PG 64-22.

Chip Seal Emulsion

Practitioners in California use a polymer modified cationic rapid set (PMCRS2h) or a polymer modified anionic rapid set (PMRS2h) emulsion for chip sealing; selection is based on compatibility with the aggregate. Chip seal emulsion for other areas should be placed in accordance with the area's state specifications.

The County of San Diego follows state guidelines but also requires both properties for Torsional Recovery and Polymer Content properties be met, where the state only requires one or the other. Contractors are required to furnish and place all materials; the emulsion selected is based on compatibility with the aggregate.

Chip Seal Aggregate

Chip seal aggregate varies from region to region depending on the aggregate source. The recommended properties and application rate for chip seal aggregate in a region should be consistent with its state specifications.

Material Application Rates

Fabric Binder

Binder application rates differ in Northern and Southern California because of ambient temperatures inherent with each location, and how quickly the fabric can be placed and

embedded in the binder to insure fabric saturation yet avoid premature saturation (due to extreme heat).

Southern California typically performs this type of construction after the peak of summer when the temperatures are less than 110°F (43°C), but before the onset of cooler temperatures that will prevent the successful placement of the chip seal. Due to the difference in ambient and pavement temperatures between Northern (cold climate) and Southern California (moderate and warm climate), the reader should note the difference in the liquid asphalt (fabric binder) application rates below (Table 2):

Table 2. Liquid Asphalt Application Rate

Asphalt Grade	Application Rate	Location
PG 64-22 or PG 67-22	0.30 to 0.35 gal/yd^2 (1.45 to 1.8 liter/m^2)	Cold Climate
PG 64-22 or PG 67-22	0.25 to 0.30 gal/yd^2) (1.1 to 1.45 liter/m^2)	Moderate and Warm Climates

SITE SELECTION

Roadways Recommended for Paving Fabric

Chip sealing over paving fabric has been found successful surface treatment on oxidized roadways that have sound structural sections (Photograph 2). Isolated areas of distress in the structural section should be repaired prior to the application of this surface treatment in order to obtain the same level of success. Cracks wider than 1/4-inch should be filled with a suitable crack filler material prior to placing the fabric binder; if not, chip loss may be experienced over the underlying crack opening.

Photograph 2. Fabric Placement on Roadway with Sound Structural Section

This surface treatment performs well with low and high volume roads, and with low and high speed traffic. This surface treatment is best suited for roads that have:

- Sound structural section
- Gradual curves or are straight
- Few driveways or intersections
- Vertical grades of 10 percent, or less

Roadways Not Recommended for Paving Fabric

Experienced users have great success in extreme weather conditions; however, new users should be conservative with site selection to insure success and gain product placement experience.

This process is not successful if the roadway is subject to exposure from subsurface water penetration, or if the roadway is exposed to ponding surface water after product placement – these situations may cause the fabric to delaminate.

Because single and double chip seals are not as thick as an asphalt concrete overlay, the underlying paving fabric is exposed to more surface lateral stresses. Because of this reason, fabric placement is not recommended at the following locations:

- Vertical grades greater than 10 percent
- Horizontal curves of 200-foot radius, or less
- Bubble portion of cul de sacs
- Last 100 feet approaching intersections with controlled stops (e.g., traffic signals, STOP/YIELD traffic signs)
- Roads with average daily traffic volumes greater than 10,000
- Climate conditions where freeze-thaw cycles are severe
- Low lying wetland areas without proper drainage
- Road base and sub-base saturated from subsurface water

PRODUCT PLACEMENT

When designed properly, this construction process is no different than any other construction process. It requires a conscientious construction crew, construction equipment that is in good working order, proper inspection, and material sampling and testing to insure compliance with the project specifications and a successful end product.

Climate Conditions

The temperature requirements for applying the fabric binder and chip seal emulsion differ greatly. Therefore, in order to insure a successful application it is important the more restrictive temperature requirement be adhered to in the field to guarantee success with adhesion of all materials.

The Asphalt Institute recommends the minimum ambient temperature for asphalt concrete resurfacing operations, which includes tack coat placement, be 50°F (10°C). For chip sealing, the Asphalt Institute recommends the pavement temperature be a minimum of 70°F (21°C), and ambient pavement be between 70°F (21°C) and 110°F (40°C). Therefore, fabric binder application should adhere to the chip seal temperature requirements to insure successful application of the chip seal. Also, paving fabric placement operations should not begin if cool or inclement weather predicted in the forecast.

Methods of Placement

The construction operation consists of two phases, fabric placement and chip seal placement. Some agencies add fog sealing as a third phase – this would occur after the chip seal is applied

and is done to enhance striping visibility, insure chip retention, and eliminate multiple post-sweepings to remove any loose aggregate.

In Southern California, the method of how and when the paving fabric and chip seal are placed is determined by the traveling speed of the motoring public (high-speed vs. low-speed) roads, not the road's average daily traffic (ADT).

High-speed roads are roads that are unposted or have posted speed limits greater than 25 miles per hour (40 kilometers per hour). This situation requires the paving fabric and chip seal be placed on the same day to insure high-speed traffic cannot do excessive braking on the paving fabric.

Low-speed roads are roads that have posted speed limits of 25 miles per hour (40 kilometers per hour). This situation requires the chip seal be placed 5 to 10 days after the paving fabric is placed – this allows the fabric binder to cool and harden, and allow slow-speed traffic to provide additional rolling to insure fabric embedment into the fabric binder.

Key Issues in Product Placement

In order to guarantee success, one must respect how the placement of one material affects the placement of the next material.

During all phases of the construction operation it is important to have a clean road surface, chip seal emulsion formulated for existing field conditions, surface damp and clean aggregate, required ambient and pavement temperatures, construction equipment in good working order, required traffic control personnel and devices, and experienced staff.

If the necessary amount of fabric binder is applied to insure fabric saturation after rolling, then the chip seal can be applied at the application rates specified for a pavement surface - however, there is a backup plan should fabric saturation not occur. The chip seal emulsion application rate can be increased to complete the saturation of the paving fabric and still have enough emulsion present on the fabric surface to guarantee aggregate adhesion. If for somer reason not enough emulsion was applied for the chip seal, and aggregate embedment appears marginal, a fog seal can then be applied to prevent loss of aggregate.

PERFORMANCE FINDINGS

Findings from California

Chip sealing over paving fabric projects have been very successful throughout California. Both Skip Brown and Lita Davis have reported their findings of chip sealing over paving fabric in Transportation Research Board (TRB) publications, as well as in trade magazines, and at state, national and international conferences.

Northern California

In Northern California, Skip Brown of Delta Construction Co., Inc. has reported 19 years of experience placing a double chip seal over paving fabric. This modified surface treatment technique was developed through trial and experimentation and has been found to add substantial pavement life at a reduced cost over typical methods of repair. This method has been applied to

alligator-cracked pavement without having to remove and replace the damaged pavement, and has reduced reflective cracks by more than 90 percent over alternate methods (Brown, 2003).

Southern California

In Southern California, Lita Davis of the County of San Diego has also reported excellent success with placing a single chip seal over paving fabric in the desert area of San Diego County. The 1987 chip seal over paving fabric test sections on Yaqui Pass Road are still functioning as of this writing. The paving fabric continues to span across the underlying surface cracks and has eliminated any maintenance need for crack filling or crack sealing in the past 22 years. All subsequent chip seal over paving fabric applications have performed with the same level of success in the desert area of San Diego County (Davis, 2003).

Findings Outside of California

Our challenge was to obtain data from regions other than California and also relate those experiences with the chip seal over paving fabric as a surface treatment. We reviewed over 30 projects throughout the United States to further define the proper application of this surface treatment. Following is a brief summary of several regional areas that experienced success with trial projects:

District of Columbia

The District of Columbia DOT selected a heavily-traveled arterial in a residential area of Washington D.C. The existing pavement was a deteriorated, full-depth pavement with a Pavement Condition Index (PCI) rating estimated less than 25 out of a possible rating of 100.

Included in the 2005 test rehabilitation project was a 2,000-foot test section with side-by-side comparison of three combinations of seal coat applications. The first section was a slurry seal over a chip seal, commonly referred to as a cape seal. The second section was a slurry seal over a chip seal (cape seal) applied over a paving fabric. The third section was a slurry seal.

The chip seal applied to the paving fabric consisted of latex modified cationic rapid set (LMCRS2) emulsion applied at 0.35 gallon/square yard, and a single layer of 3/8-inch aggregate applied at 25 pounds/square yard. The test sections were placed in October of 2005. A review of this project in 2009 confirmed that the test sections with paving fabric are performing better than the tests section without fabric.

Oklahoma

Oklahoma DOT has been placing chip seals over paving fabric since the mid-1980s. The first project was on U.S. Highway 7 near Duncan. Superior performance of this treatment has led to its incorporation as a routine procedure in Oklahoma. The Oklahoma Department of Transportation (ODOT) estimates an eight-year maximum effective life for this surface treatment, with no maintenance required after placement. On the other hand, chip seals without paving fabric are experiencing a five-year effective lifetime and require frequent crack filling.

ODOT considers chip sealing over paving fabric cost effective for roads with an ADT less than 5,000. ODOT estimates the cost savings realized in subsequent road maintenance

offsets the cost to incorporate the paving fabric interlayer - cost savings are realized in one to two years after placement. Another benefit ODOT has realized is the paving fabric interlayer's continuous ability to resist reflective cracking even with subsequent placement of asphalt concrete overlays placed on the chip seal.

South Carolina

In 1990, South Carolina DOT conducted a test section and concluded that paving fabrics improve the service life of a chip seal. South Carolina DOT reported that, in mechanical terms, the continuity of the paving fabric appears to be important when included in a chip seal because it gives to the bitumen a capacity for plastic deformation compatible with the application. (Geosynthetic 1989 Conference, J. Perfetti and T. Sangster)

Texas

Texas is a long-time user of paving fabrics and chip seals. Under direction of FHWA, Texas Department of Transportation (DOT) conducted a test section to evaluate the use of these products together. This test section is one of several test sections placed by Texas DOT to evaluate the performance of several types of chip seals with and without the use of paving fabric. The test sections included both pre-coated and uncoated aggregate, as well as different tacks coats including modified and standard emulsions and performance based (PB) graded asphalts.

FHWA and Texas DOT evaluated the test sections three years after placement and concluded, "Chip seals with geotextile fabrics (paving fabrics) are doing a better job of controlling reflecting cracks" (Texas DOT Research Study with Luis Rodriguez of FHWA).

Williamsburg, Virginia

Installed 1994 and reviewed in 2005, by the 11-year test section with paving fabric continues to provide an attractive and useful pavement surface, and a moisture barrier to the underlying oxidized pavement (John Sikich, President of Road Fabrics).

Cold Weather Test Sections

In 2007, test sections were placed in the lowest temperature regions in the United States - Minnesota. Agencies that participated in the test sections were very interested in any process that will prolong their chip seal program. Currently, the agencies' chip seals last four to six years and require a surface treatment after that period.

Test sections were monitored, at a minimum, every three months. During the first winter, thermal cracks occurred every 10 to 20-feet at the normal freeze-thaw intervals. The thermal crack opening grew up to 2 inches in width. Chip loss occurred at the thermal cracks, and 2 to 3 inches beyond the crack – this occurred because cracks were not filled prior to fabric placement. After the winter months when thermal cracks tend to reduce in width, chip loss was still evident in the vicinity of the thermal cracks. However, the asphalt saturated paving fabric maintained its integrity and continued to provide a moisture barrier to the underlying pavement.

These test sections determined that a road is not a good candidate for chip sealing over paving fabric if the pavement experiences freeze-thaw cycles with a 3-month average low

temperature less than 15°F (< -9°C), combined with a 3-month average high temperature greater than 78°F (>25°C), throughout the year.

Photograph 3 shows an example of transverse thermal cracking at a joint, which resulted in chip loss due to expansion at the joint. It is interesting to note that the paving fabric maintained its integrity by being flexible with the expansion and contraction of the joint, and also continued to perform as a waterproofing barrier.

Photograph 3. Paving fabric maintains flexibility with joint expansion/contraction.

Illinois

City of Newton, IL (2005)

The City of Newton has a 3-year chip seal cycle for maintaining its roadways.

Materials: CA 16 crushed chips at 20 pounds/square yard, RC-70 chip seal emulsion at 0.25 gallon/square yard, 4-ounce CS paving fabric with PG 64-22 asphalt tack coat at 0.25 gallon/square yard.

Road preparation: Cracks in pavement were not filled prior to placement of paving fabric.

Results: Very successful performance with the exception of some transverse cracking and shoving appeared at business entrance due to construction equipment. Due to the overall performance of the three-year old chip seal over paving fabric test section, routine chip sealing was not required. Roadways that did not use paving fabric required subsequent chip sealing.

Michigan

Berrien County Test Section Yore Ave (2008)

Materials: Indiana # 11 hot blast furnace slag (MDOT-25-A slag) at 18 pounds/square yard, high float rapid set (HFRS 2A) chip seal emulsion at 0.43gallon/square yard, 4-ounce CS paving fabric with PG 64-22 asphalt tack coat at 0.30gallon/square yard.

Road preparation: Severe alligator cracked pavement received a leveling course prior to placement of paving fabric.

Results: The test section is performing well compared to the non-fabric test section.

Van Buren County, 64th Street (7/ 2008)
Materials: Indiana # 11 hot blast furnace slag (MDOT-25-A slag) at 20 pounds/square yard, HFRS 2A chip seal emulsion at 0.43 gallon/square yard, 4-ounce CS paving fabric with PG 64-22 asphalt tack coat at 0.27gallon/square yard.
Road preparation: Cracks in pavement were sealed in 2007.
Results: The Van Buren section preformed the poorest with some chip loss in a low lying area which appears to be saturated with ground water. The paving fabric delaminated due to exposure to water from the subgrade (Photograph 4).

Photograph 4. Van Buren County Test Section
Fabric delaminated due to subsurface water pressure

Summary of Cold Weather Test Sections

With the exception of Minnesota, the cold weather test sections had acceptable climate conditions for placing a paving fabric prior to a chip seal as an effective pavement preservation surface treatment. Minnesota and other regions that have extreme weather conditions were not good candidates for this paving fabric interlayer system.

Test sections confirmed that it is important in colder climates, such as Colorado and Michigan where the average cold temperatures drop below 15°F (-9°C) over a three-month period, that a heavy application of the asphalt tack coat be placed for the paving fabric. This is attained by selecting the proper fabric type depending on temperature zone (Table 3).

Table 3. Recommendations for Paving Fabrics in Temperature Zones Based on Three-Month Average Low Temperatures

Climate Zone	Three-Month Average Low Temperature	Fabric Type
Warm	>42°F (>6°C)	Light Duty or Standard
Moderate	>24°F (>4°C)	Standard
Cold	>15°F (>-9°C)	Standard Paving Fabric with an Increase in Application of Fabric Binder (Tack Coat)
Severe	<15°F (<-9°C)	Not Recommended

Other areas to avoid, regardless of weather conditions, are areas where the pavement is exposed to water from the subgrade such as in low lying or wetland areas. Caution should also be taken to provide proper pavement drainage measures in advance of placing the paving fabric.

Cracks wider than 1/2 inch should be filled in advance in order to extend the life of this paving fabric interlayer system, and to avoid chip loss over the open cracks.

Sanding and rolling the paving fabric, to insure asphalt saturation, was more effective than not rolling the fabric prior to chip sealing. Excess sand should also be swept from the paving fabric surface in order to provide a clean surface for the chip seal emulsion.

Construction practice of placing a chip seal should meet the State DOT specification for the region. Under normal conditions, the chip seal emulsion/binder application rate must not be reduced when placed over a paving fabric. Adhering to minimum temperature requirements is critical when placing the paving fabric or chip seal. The pavement surface must be clean and dry prior to application of any materials.

ENVIRONMENTAL BENEFITS

Most manufacturers recycle 10 percent of post-industrial waste into the manufacturing of paving fabrics. The 10 percent credit is defined under Leadership in Energy and Environmental for New Construction (LEED) MR 4.1 for pre-consumer waste. The fiber is obtained from the manufacturing process which includes resin, resin pellets and fiber. The waste from manufacturing is graded by strict quality control measures, and extruded into fiber for the manufacturing of paving fabrics.

Future projects can also use Green paving fabrics which contain over 25 percent of post-consumer waste which is primarily obtained by recycled plastic.

The largest environmental benefit of using paving fabrics with a chip seal is the extended life that paving fabrics provide when placed with a chip seal. The chip seal-paving fabric surface treatment extends the life of the chip seal portion itself, from two to three times, over what is typically experienced with a chip seal without paving fabric.

ECONOMIC BENEFITS

Life Cycle Cost Analysis

In 1999, the County of San Diego performed a 30-year Life Cycle Cost analysis and found the chip seal over fabric eliminated reflective surface cracks and the subsequent need for crack sealing. Moreover, the 30-year life cycle cost analysis showed that the annual cost was one half that of chip sealing with crack sealing.

SUMMARY

The ultimate responsibility of public agencies is to recognize they are the trustees of the funds provided by the taxpayer, and are relied upon to apply sound engineering judgment in maintaining and preserving the public road system. This study to place and evaluate test sections involving chip seals over paving fabric throughout the United States was done in an effort to determine what climatic regions can benefit from this surface treatment. As a result of this study

many regions are able to perform the same rate of success as those in northern and southern California and regions were identified that are not good candidates to obtain success.

As stated earlier, the 1987 test section placed in San Diego County continues to perform as of this writing with no subsequent road maintenance; this success is also being experienced in Northern California for projects 19 years old. Both areas report the chip seal over paving fabric continues to maintain the structural integrity of the roadways, protect the underlying road base, and that no road maintenance has been performed to date. This success is directly attributed to selecting roads that were prime candidates for receiving a chip seal over paving fabric.

Because of the innovation and experience attained throughout California, and the desire of agencies throughout the United States to test and determine if they are able to obtain the same success in their region. This study was able to quantify the climatic areas where chip sealing over paving fabric has been performed successfully, and what climatic or environmental conditions prevent successful performance from occurring.

Those agencies that have experienced success are able to add this combined surface treatment into their pavement preservation toolbox for extending or maintaining the life of a flexible pavement.

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