PAVEMENT PRESERVATION PROCESS AT THE MARYLAND STATE HIGHWAY ADMINISTRATION

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ABSTRACT

The need for pavement preservation is widely recognized by transportation agencies. Over the past few years, the Maryland State Highway Administration (MDSHA) has made significant advancements in developing guidelines for pavement preservation in Maryland. The Pavement and Geotechnical Division (PAGD) within MDSHA has developed a pavement preservation guide that will assist in determining "the right fix for the right road at the right time" when used in conjunction with network-level and project-specific data. This guide was developed based on review of state-of-the-practice literature pertaining to pavement preservation, past experiences and the resource base of MDSHA pavement engineers. Step-by-step instructions on determining treatment options were developed through the use of flow charts, decision trees and treatment tables. At the end of the step-by-step process, there will be many viable treatment options available for consideration. In addition, various treatment options are also defined, along with information regarding treatment cost, advantages, disadvantages and other items. These options, along with the use of good judgment, common sense and research of current best practices help facilitate good decision-making. The ultimate selection of a preservation strategy by the District is based on the most cost-effective engineering design considering cost, practicality of construction, and benefit in terms of life extension. This paper presents an overview of the guide as of December 2014. Updates are made to this guide as new paving technologies emerge, and as feedback about performance of treatments is available. Efforts are also underway to integrate this guide into the pavement management optimization analysis.

KEYWORDS

Pavement maintenance, pavement preservation, pavement maintenance treatment selection, flexible pavements, rigid pavements, composite pavements

OVERVIEW

The need for pavement preservation is widely recognized by transportation agencies. Over the past few years, the Maryland State Highway Administration (MDSHA) has made significant advancements in developing guidelines for pavement preservation in Maryland. Organizationally, all pavement management and pavement design efforts are conducted centrally within the Pavement and Geotechnical Division (PAGD) of the Office of Materials Technology (OMT) with funding and project selection approved through the Office of the Chief Engineer (OCE). Each engineering District makes the final decision on project and treatment selection.

PAGD has developed a pavement preservation guide (*1*) that contains step-by-step instructions on determining viable treatment options for a given project. This guide was developed based on review of state-of-the-practice literature (*2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)* pertaining to pavement preservation, local knowledge, past experiences and the resource base of MDSHA pavement engineers. The step-by-step instructions were developed through the use of flow charts, decision trees and treatment tables. At the end of the step-by-step process, there will be many viable treatment options available for further consideration by the District. One or a combination of treatment options may be selected, depending on project-specific conditions. It is not the intent of this guide to provide a final treatment option(s). It is anticipated that further project-specific review, analysis and design will be required. Therefore, the final treatment option(s) will be

determined by the District offices in coordination with the PAGD. In addition, various treatment options are defined, along with information regarding treatment cost, advantages, disadvantages and other items. Many of the treatments in the guide are unfamiliar to MDSHA at this time, but are being utilized by various state, county and local transportation agencies throughout the country. The guide was originally developed in May 2011 and updates are made as new paving technologies emerge, and as feedback about performance of treatments is available. This paper presents an overview of the guide as of December 2014.

IMPLEMENTING PAVEMENT PRESERVATION INTO MDSHA'S PM SYSTEM

The OCE provides the Pavement Management (PM) Section of the PAGD with the total construction budget for every fiscal year. The PM Section will run an optimization analysis to determine how the total construction budget should be distributed among the Districts. This is done accounting for a variety of pavement conditions, types, locations, and targets. The optimization program also takes into account that an identical project in an urban district costs more than a rural district due to other non-paving factors. It also takes into account that some functional classes, such as Interstates, are held to a higher standard than other roadways. In addition, ongoing or planned projects are also considered in the optimization.

Once this initial optimization run is complete, the PM Section provides a project candidate list to each District, giving an overall District lane-mile-year (LMY) target. With that, the Districts also receive an itemized list of suggested projects and treatments that can meet the targets. This list is a suggestion only, so the Districts do have the option to choose different projects and different fixes, with the goal of meeting the LMY targets. Efforts are currently underway to include all the treatments identified in the pavement preservation guide into the optimization analysis.

No targets are established for accomplishing a minimum amount of lane-miles, nor will Districts be required to implement a minimum amount of rehabilitation or preservation. However, they are strongly encouraged to program many more preservation activities than have been done in the past, in accordance with the selection criteria in the pavement preservation guide. The Districts will be given a suggested number of lane-miles to address through rehabilitation, and another amount of lane-miles to address through preservation in an effort to guide them in programming a sufficient amount of preservation activities.

Once the Districts receive their LMY targets and suggested project candidates, they will work with their counterparts in PAGD to determine specific projects and fixes. The pavement designers provide an estimated fix life so that the LMY can be calculated. The PAGD designers will estimate Fix Life through a variety of engineering practices such as AASHTO 93 pavement design guide standards, Remaining Service Life analysis, MDSHA's Pavement Design Guide, existing pavement conditions, historical performance of the roadway by analyzing the pavement management data, and cost-to-benefit ($/LMY) analysis. The ultimate selection of a pavement preservation strategy for any project will be based on the most cost-effective engineering design considering cost, practicality of construction, and benefit in terms of life extension provided to the network.

PROJECT SELECTION PROCESS AT MDSHA

As noted before, the PM section provides the Districts with a preliminary list of candidate projects along with the plan targets for benefit (in terms of LMY) and the allocated budget. Then, the District offices in coordination with the PAGD determine the final candidate projects for construction. For each project on this final list, the PAGD design engineers perform an initial treatment selection using the pavement preservation guide, which is explained further in the following sections.

FRAMEWORK FOR INITIAL TREATMENT SELECTION

The initial treatment selection procedure described in this section will be followed by the PAGD design engineers to identify the list of viable treatment options that could be appropriate fixes.

Step 1: Conduct a visual condition assessment:

The first step is to conduct a site visit to document the pavement type and the condition of the existing pavement. This information will be verified with available data in MDSHA's pavement management database called the PM Base®. If the pavement type is flexible or composite, Steps 2 and 3 are followed to determine the possible list of viable treatment options as per Figure 1. If the pavement type is concrete, Step 4 is followed to determine the possible list of viable treatment options as per Figure 2.

Step 2: Obtain traffic and pavement performance data (asphalt-surfaced pavements only):

The second step is to obtain traffic data in terms of Average Daily Traffic (ADT) and the pavement performance data from the PM Base® system. The pavement performance data needed is International Roughness Index (IRI), Cracking Index (CI), Skid Number (SN), and Average Rutting (in.). The CI data is available in the form of Functional Cracking Index (FCI) and Structural Cracking Index (SCI).

The distresses that comprise FCI are:

- Bleeding
- Block Cracking
- Bumps and Sags
- Corrugation
- Joint Reflective Cracking
- Lane/Shoulder Drop-off
- Polished Aggregate
- Slippage Cracking
- Transverse Cracking
- Weathering and Raveling

The distresses that comprise SCI are:

- Alligator (Fatigue) Cracking
- Depression

- Longitudinal and Edge Cracking
- Patching/Potholes

The definitions of the distresses are as per the Asphalt Distress Paver Manual of the U.S Army Corps of Engineers (*13*)

Step 3: Determine the viable treatment options (asphalt-surfaced pavements only):

Using the ADT and the IRI information, the decision tree shown in Figure 1 will direct the user to one of nine Treatment Matrices (TM 1 through TM 9). Figure 3 shows TM 1 for an asphalt-surfaced pavement with ADT: ≤ 4,000 and IRI ≤ 100. TM 2 through TM 9 for all the other scenarios are presented in the MDSHA pavement preservation guide (*1*) and are available upon request. The treatment matrices will use the SCI, FCI, SN, and Average Rutting information to provide a list of viable treatment options. The treatment matrices contain treatment numbers which are explained in Table 1.

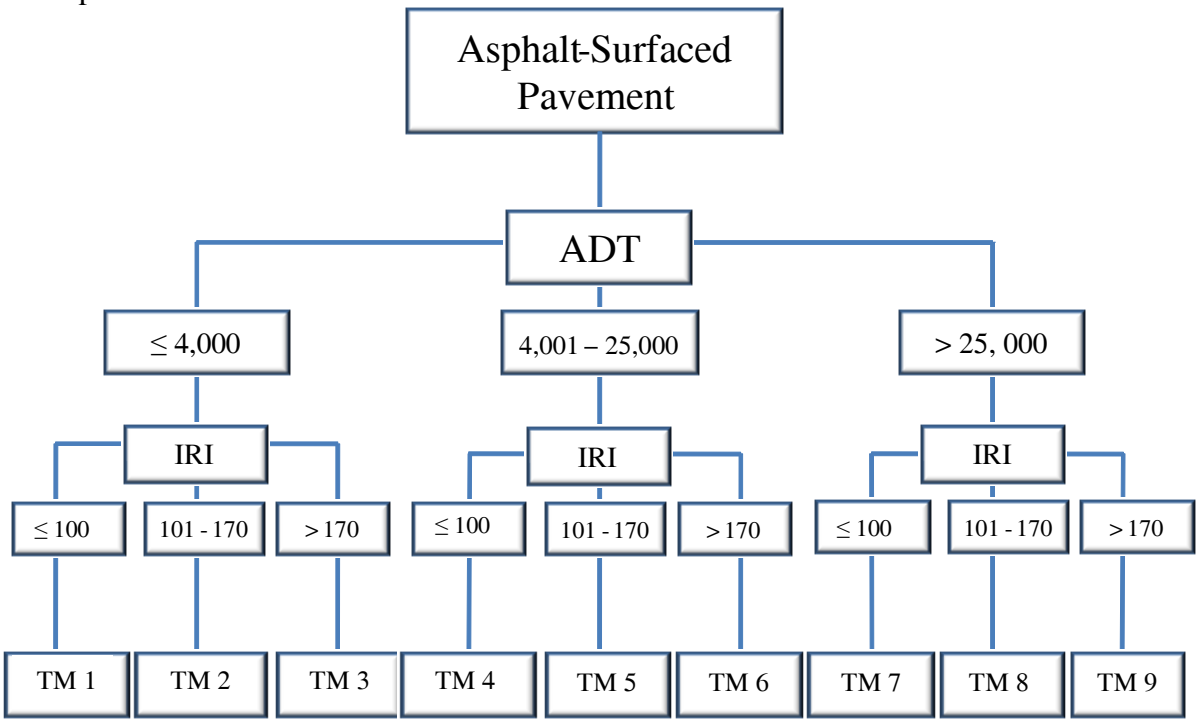

FIGURE 1 Decision tree for Asphalt-Surfaced pavements.

Step 4: Determine the viable treatment options (for rigid pavements only):

The decision tree in Figure 2 will be used to determine the possible list of viable treatment options for rigid pavements.

AMERICANS WITH DISABILITIES ACT (ADA) TRIGGERS:

One of the factors also considered in the final treatment selection is whether a given treatment is considered an alteration as per the Federal Highway Administration (FHWA) and the US Department of Justice (DOJ) memorandum (*14*). Table 1 presents the list of treatments and whether they are considered ADA triggers. If a treatment is an ADA trigger, then it is considered an

alteration that triggers ADA work such as adding curb ramps. It should be noted that High Friction Surface (HFS) treatments are for spot locations, and ADA alterations may be triggered if HFS is placed for longer stretches. Full-depth patches are considered an alteration if they span curb to curb.

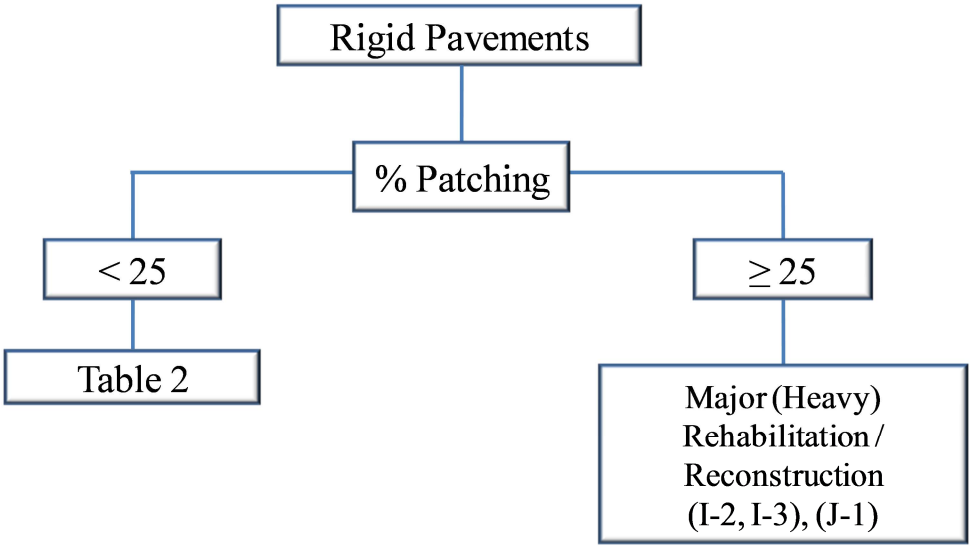

FIGURE 2 Decision tree for Rigid pavements.

TABLE 1 List of Treatment Activities and ADA triggers

Treatment Group	ID	Treatment	ADA Trigger?
A. Crack/Joint Seals	A-1	Crack Fill & Crack Seal (Asphalt)	No
	A-2	Crack Seal (PCC Surface)	No
	A-3	Joint Sealing (and Resealing)	No
	A-4	Saw and Seal	No
B. Asphalt Sealers / Rejuvenators	B-1	Fog Seal	No
	B-2	Rejuvenators	No
C. Aggregate Seals	C-1	Cape Seal	Yes
	C-2	Chip Seal (Modified)	No
	C-3	High Friction Surface	No
	C-4	Sand Seal	No
	C-5	Sandwich Seal	No
	C-6	Scrub Seal	No
	C-7	Slurry Seal	No
	C-8	Micro-surfacing	Yes
D. HMA Overlay	D-1	Thin Overlay	Yes
	D-2	Grind & Overlay	Yes
	D-3	Overlay	Yes
	D-4	Wedge/Level & Overlay	Yes
	D-5	Hot-In-Place HMA Recycling (HIR)	Yes
E. PCC Overlay	E-1	PCC Overlay - Unbonded	Yes
	E-2	PCC Overlay - Bonded	Yes
F. Patch	F-1	HMA Patch	No
	F-2	Partial-Depth Patch (Spall Repair) (Rigid Pavements)	No
	F-3	Full-Depth Patch (Rigid Pavements)	No
G. Joint Treatments	G-1	Cross-Stitching	No
	G-2	Dowel Bar Retrofit	No
	G-3	Undersealing/Slab Stabilization	No
H. Surface Texturizing	H-1	HMA Diamond Grinding	No
	H-2	PCC Diamond Grinding	No
	H-3	Surface Carbide Grinding	No
	H-4	Diamond Grooving	No
	H-5	Surface Abrasion	No
I. Major (Heavy) Rehabilitation	I-1	Cold-In-Place HMA Recycling (CIR)	Yes
	I-2*	Break/Crack & Seat and HMA Overlay	Yes
	I-3*	Rubbilization and HMA Overlay	Yes
J. Reconstruction	J-1	Reconstruction	Yes
	J-2	Full-Depth Reclamation (FDR)	Yes

**I-2 and I-3 apply to composite pavements (asphalt over concrete) and rigid pavements only.*
Note: D-2 shall replace D-3; and D-4, D-5 and I-1 do not apply to pavements with predominant curb and gutter within the project limits.

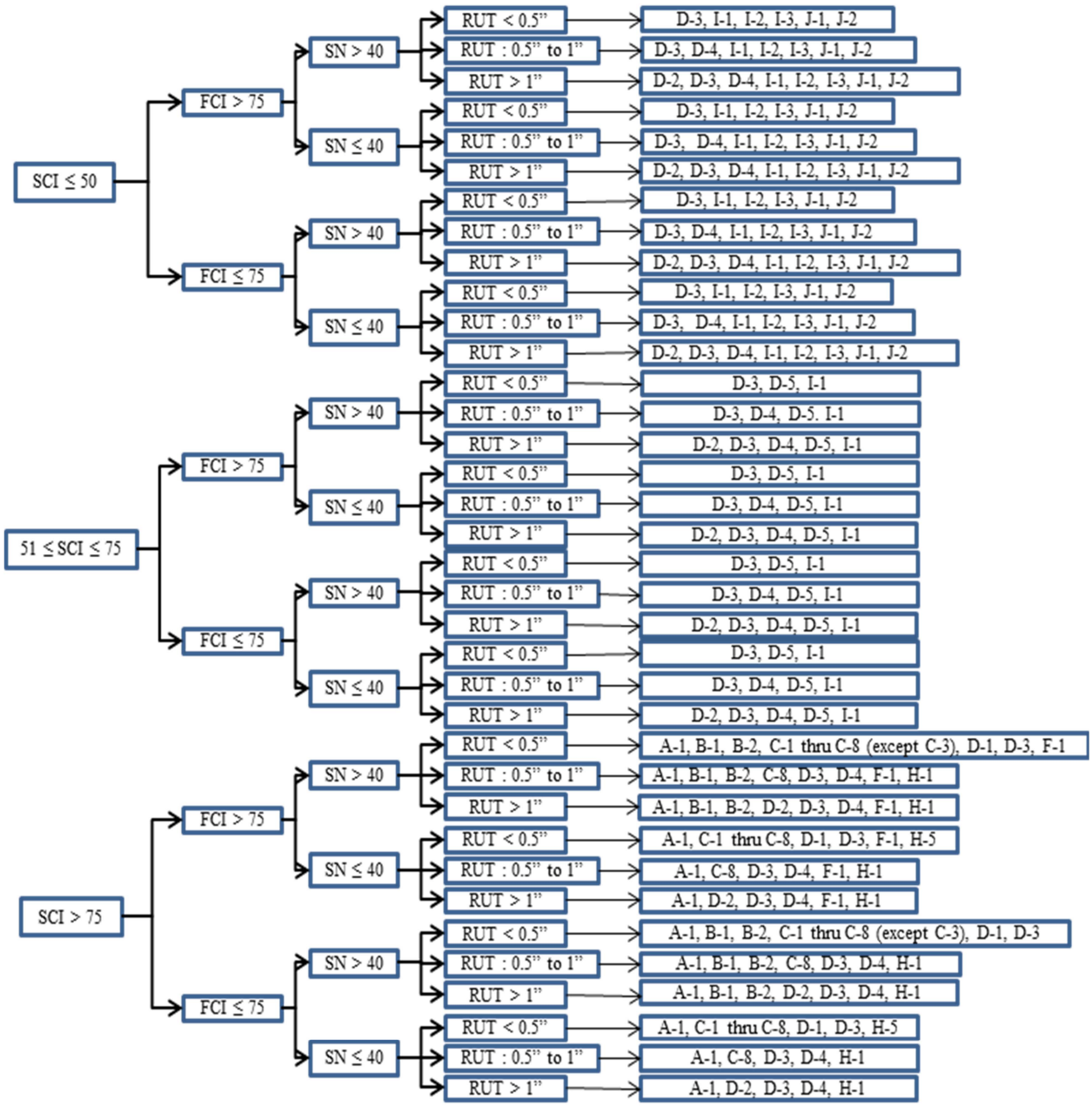

FIGURE 3 Treatment Matrix for Asphalt Surfaces with ADT: 0 to ≤ 4,000 and IRI: 0 to ≤ 100.

TABLE 2 Treatment Matrix for Rigid Pavements

	Pavement Surface: Concrete ; Patching < 25%			
Structural Distress	**Cracking (≥ 5% of slabs)**	**Pumping (≥ 5% of slabs)**	**Joint/Crack Deterioration (including Faulting) (≥ 8% of slabs)**	**Punchouts (≥ 5/mile)**
Punchouts (≥ 5/mile)	Crack/Joint Seal (A-2, A-3) Patch (F-3) Joint Treatments (G-1, G-2)	Patch (F-3) Joint Treatments (G-2, G-3) Drainage Improvements	Crack/Joint Seal (A-2, A-3, A-4) HMA Overlay (D-3) PCC Overlay (E-1, E-2) Patch (F-2, F-3)	Patch (F-3)
Joint/Crack Deterioration (including Faulting) (≥ 8% of slabs)	Crack/Joint Seal (A-2, A-3, A-4) HMA Overlay (D-3) PCC Overlay (E-1, E-2) Patch (F-2, F-3) Joint Treatments (G-1, G-2, G-3)	Crack/Joint Seal (A-3, A-4) HMA Overlay (D-3) PCC Overlay (E-1, E-2) Patch (F-2, F-3) Joint Treatments (G-2, G-3) Drainage Improvements	Crack/Joint Seal (A-2, A-3, A-4) HMA Overlay (D-3) PCC Overlay (E-1, E-2) Patch (F-2, F-3) Joint Treatments (G-1, G-2, G-3)	
Pumping (≥ 5% of slabs)	Crack/Joint Seal (A-2, A-3) Patch (F-3) Joint Treatments (G-1, G-2, G-3) Drainage Improvements	Patch (F-3) Joint Treatments (G-2, G-3) Drainage Improvements		
Cracking (≥ 5% of slabs)	Crack/Joint Seal (A-2) Patch (F-2, F-3) Joint Treatments (G-1, G-2)			

Notes:

1. *Definitions of distresses as per the Concrete Distress Paver Manual of the U.S. Army Corps of Engineers (15)*
2. *If functional distresses (scaling, popouts, shrinkage cracks, etc.) are present, consider Grind (H-2) or Surface Abrasion (H-5).*
3. *If shallow durability problems such as "D" cracking, and Alkali Silica Reactivity (ASR) are present, consider Grind (H-2) and Overlay (D-3, E-2). It should be noted that this strategy does not address the systemic problems associated with "D" cracking and ASR, and are only temporary solutions to the durability problems.*

ROUTINE MAINTENANCE FOR RIGID PAVEMENTS:

MDSHA does not have a routine maintenance schedule for asphalt-surfaced pavements. In partnership with the concrete industry, a routine maintenance schedule for rigid pavements has been developed which is described in this section.

Regardless of the existing pavement condition, MDSHA has adopted the following policy for routine maintenance of rigid pavements with sealed joints:

- Drainage outlets should be inspected every 2 years and maintained as needed.
- Years 10-12 and Year 20: Reseal joints.
- Year 25: If no treatments (aside from joint resealing) have yet been scheduled as a result of network-level condition assessments, a project-level assessment as per Table 2 to determine treatment needs is performed.
- Year 25 and beyond: For the years of 25 and beyond, a project-level assessment is made as per Table 2 to determine treatment needs every 5 years.

Regardless of the existing pavement condition, MDSHA has adopted the following policy for routine maintenance of rigid pavements with unsealed joints:

- The current design for concrete pavements in the State of Maryland specifies the following:
  - Joints shall be single 1/8" saw-cut to a depth of 2" and shall not be sealed. Unsealed joints require increased frequency of drainage outlet inspection and maintenance. Unsealed joints allow for the possibility of more water to enter the system; therefore, proper drainage must be maintained or base materials may become soft and erode, creating structural issues. A yearly inspection should be conducted without fail. Plugged drains should be cleared. If joint spalling develops due to the unsealed condition, provisions to seal the joints should be made as per Table 2.
- The following maintenance schedule is recommended for all pavements with no joint seal:
  - Drainage outlets should be inspected every year and maintained as needed.
  - Year 25: If no treatments have yet been scheduled as a result of network-level condition assessments, a project-level assessment as per Table 2 to determine treatment needs is performed.
  - Year 25 and beyond: For the years of 25 and beyond, a project-level assessment be made as per Table 2 is performed to determine treatment needs every 5 years.

NEW PAVEMENT PRESERVATION TREATMENTS

Since the implementation of the pavement preservation guide in May 2011, the MDSHA has placed several new pavement preservation treatments:

- Slurry Seal
- Microsurfacing
- Surface Abrasion
- Rejuvenators
- Fog Seals

So far, these treatments have been performing as expected, and the Districts continue to look for candidate projects where new pavement preservation treatments could be considered.

SUMMARY

The development of the Pavement Preservation Guide is a significant step forward for MDSHA to efficiently and effectively manage the pavement network. This guide will assist in determining "the right fix for the right road at the right time" when used in conjunction with network-level and project-specific data. This guide is not intended to override or replace the necessary use of good judgment, common sense and research of current best practices. The ultimate selection of a preservation strategy for construction is based on the most cost-effective engineering design considering cost to the MDSHA, practicality of construction, and benefit in terms of life extension provided to the MDSHA pavement network. Updates are made to this guide as new paving technologies emerge, and as feedback about performance of treatments is available. It is realized that communication among the Districts, PAGD and industry partners is the key to the continued success of the implementation of this guide.

REFERENCES

1. *Pavement & Geotechnical Design Guide.* Office of Materials Technology (OMT), Maryland State Highway Administration, 2014.

2. *Concrete Pavement Field Reference Preservation and Repair*. American Concrete Pavement Association, Illinois, 2008.

3. *The Concrete Pavement Restoration Guide.* American Concrete Pavement Association, Illinois, 1997.

4. *Manual Series No. 17 (MS-17), Asphalt Overlays for Highway and Street Rehabilitation.* Asphalt Institute, Kentucky, 2000.

5. *Basic Asphalt Recycling Manual.* Asphalt Recycling and Reclaiming Association, Maryland, 2001.

6. *Pavement Preservation: Optimal Timing of Pavement Preservation Treatments*. Federal Highway Administration, Washington D.C, 2007.

7. *Pavement Preservation: Preventive Maintenance Treatment, Timing, and Selection*. Federal Highway Administration, Washington D.C., 2007

8. *Guide to Concrete Overlays*. National Concrete Pavement Technology Center, Iowa, 2008.

9. *Pavement Maintenance Manual*. Nebraska Department of Roads., Nebraska, 2002.

10. *Maintenance Technical Advisory Guide (TAG).* State of California Department of Transportation, California, 2003.

11. *Hot-Mix Asphalt Paving Handbook 2000*. United States Army Corps of Engineers, Washington, D.C., 2000.

12. *SHRP2 Renewal Research (SHRP2 Report S2-R26-RR-2): Guidelines for the Preservation of High-Traffic-Volume Roadways.* Transportation Research Board, Washington D.C, 2011.

13. *Pavement Distress Identification Guide for Asphalt-Surfaced Roads and Parking Lots*. US Army Corps of Engineers, 1997.

14. *Department of Justice/Department of Transportation Joint Technical Assistance on the Title II of the Americans with Disabilities Act Requirements to Provide Curb Ramps when Streets, Roads, or Highways are Altered through Resurfacing.* Federal Highway Administration. http://www.fhwa.dot.gov/civilrights/programs/doj_fhwa_ta.cfm. Accessed August 22, 2014

15. *Pavement Distress Identification Guide for Jointed Concrete Roads and Parking Lots*. US Army Corps of Engineers, 1997.