Interim Guidelines for Thin Maintenance Surfaces in Iowa

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The first phase of a two-phase research project was conducted to develop guidelines for Iowa transportation officials on the use of thin maintenance surfaces (TMS) for asphaltic concrete and bituminous roads. Thin maintenance surfaces are seal coats (chip seals), slurry seals, and micro-surfacing. Interim guidelines were developed to provide guidance on which roads are good candidates for TMS, when TMS should be placed, and what type of thin maintenance surface should be selected. The guidelines were developed specifically for Iowa weather, traffic conditions, road-user expectations, and transportation official expectations.

INTRODUCTION

The use of thin maintenance surfaces (TMS) can be a cost-effective approach for maintaining the quality of pavement. These surfaces are usually applied to flexible pavements. They include seal coats, slurry seals, and micro-surfacing.

Seal Coats are constructed by spraying binder on the road (usually emulsified asphalt) and then spreading aggregate before the binder sets. The aggregate is rolled into the binder to ensure that it remains in place. The aggregate may be rock chips, pea gravel, or sand. A seal coat made with rock chip aggregate is sometimes called a chip seal, while a seal coat made with sand is sometimes called a sand seal. Double seal coats are constructed by successively placing two layers of aggregate.

Slurry Seal is produced by mixing the aggregate and binder in a mobile mixing machine. The binder is usually asphalt emulsion, and the aggregate varies in size and type, depending on the application. Portland cement, hydrated lime, or aluminum sulfate is often added to aid in setting the slurry. The slurry is applied with a spreader box that is pulled behind the mixing truck and distributes and finishes the slurry.

Micro-surfacing is similar to slurry seal technology. Polymer-modified binder and one-hundred percent crushed aggregate is used. Micro-surfacing cures faster and may be applied in a thicker layer than slurry seal.

Studies have shown that transportation agencies can maintain a road network with better pavement condition at a lower cost by properly using TMS. In planning TMS programs, project selection, treatment selection, and timing are extremely important. Projects must be selected for maintenance when TMS are still effective. In most cases, the proper time to apply the TMS is before the need is apparent to the casual observer. This is because once pavements start to deteriorate, they deteriorate rapidly beyond the point where TMS is effective. Maintenance planners may be reluctant to order treatments for roads that appear to be structurally sound, when nearby roads appear to be in greater need of repair. However, when TMS applications are properly timed, road networks will show improvements in service life over the long term *(1)*.

TMS do not increase the structural rating of the road and will fail quickly if applied to a road that is experiencing a structural failure. Cracks reflect quickly through slurry seals and micro-surfacing. Therefore, these treatments should be applied before cracks form or in conjunction with crack maintenance programs.

It is important to select the right maintenance treatment for each situation. Pavement condition, traffic volumes, road type (urban, rural, interstate, primary, secondary), materials availability, and local preference must be considered in making this decision. For maximum benefit, TMS must be applied before pavement distress is apparent. Research has shown that pavement deteriorates slowly when it is new and then deteriorates more rapidly after it reaches a certain age (Figure 1). If the pavement is allowed to deteriorate rapidly, it will soon be necessary to rebuild the pavement, an expensive proposition. Alternatively, a thin maintenance surface may be applied that will improve the pavement condition to the point where pavement performance deteriorates slowly. Several maintenance treatments may be applied periodically to maintain the pavement above the point of quick deterioration. For each dollar spent on maintenance before the age of rapid deterioration, four dollars can be saved in rebuilding costs *(1)*. Preventive maintenance provides benefits in addition to cost savings: on the average, road users enjoy better pavement conditions when compared to a strategy of allowing the pavement to deteriorate to the point that rebuilding is necessary.

In the past, many applications of TMS have been unsuccessful because they have been applied too late and failed rapidly. After such experiences, transportation personnel tend to hesitate to use TMS. Also, it is difficult to institute a program of preventive maintenance with properly timed treatments because the public often perceives that money is being wasted on good roads while other projects are being neglected. It would be desirable to develop an assessment procedure that would allow planners to accurately determine the optimum timing of TMS and to include this assessment procedure in an overall pavement management system. Also, it would be desirable to clearly explain the need for prompt treatment of pavements before distress is apparent.

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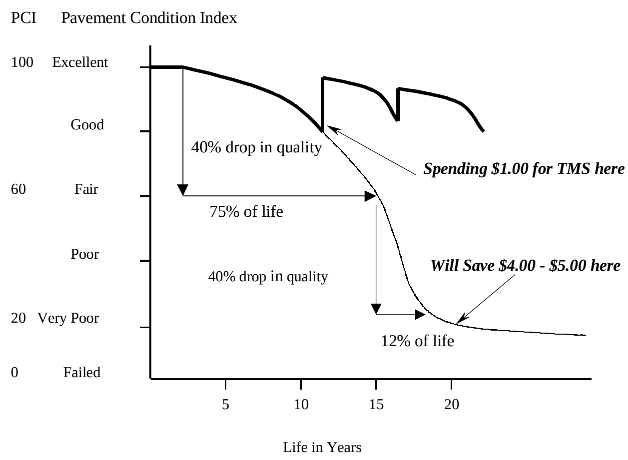

FIGURE 1 Typical pavement life cycle (*1*)

The Iowa DOT is considering the development of preventive maintenance programs. First, however, it would be desirable to develop a system for planning TMS maintenance programs that are tailored to Iowa's climate, materials, and contracting practices.

PROBLEM STATEMENT

By properly using TMS as a preventive maintenance technique, agencies can cost-efficiently maintain the surface condition of Iowa highways and streets at a high level. For this strategy to be successful, proper selection, timing, and application are critical. Previous international, national, and state research has provided a basic framework for implementing such maintenance programs in Iowa. However, it is necessary to customize this framework to address Iowa's specific needs with regard to aggregates, climate, construction practices, traffic, and fund management.

METHODOLOGY

Several steps were required to execute the study to this point. These steps are described in detail elsewhere; they are summarized below *(2, 3, 4)*. The project commenced in May 1997 with a literature review to find previously developed guidelines for TMS. Researchers also found information on materials and mix designs for TMS, as well as assessment techniques for roads that are candidates for TMS treatments. The results of the literature review are discussed in connection with specific topics throughout this report.

A survey was also conducted to determine current uses of TMS by Iowa counties and municipalities. Questions were also asked regarding contracting strategy, future plans, and needs for information.

Plans were made for observing construction and assessing the performance of TMS research test sections. Before the start of this research project, the Iowa DOT had contracted to construct a set of test sections in Linn County on US 151 northeast of Cedar Rapids and Benton County on US 30 just west of the intersection of US 218. The test sections included several types of seal coats using local aggregates, micro-surfacing, slurry seal, cape seal (seal coat with slurry top), and a thin lift hot mix overlay.

Researchers conducted a pre-construction condition survey, observed construction, and conducted three post-construction condition surveys. Due to the contractor's schedule, construction of these test sections occurred late in the construction season (September and October 1997) when cold temperatures did not allow the emulsion to cure properly. In addition, many of the application rates varied considerably from the target rates. This compromised the research value of these test sections.

Plans were then made for constructing a set of test sections during the 1998 construction season between Huxley and Alleman on US 69. These test sections were designed by the researchers in cooperation with the Iowa DOT and with Koch Materials Inc., which supplied emulsion and asphalt cement for the project. The sections included several types of seal coat using local and imported aggregate, micro-surfacing, micro-surfacing with a seal coat interlayer, a hot sand mix overlay, and a Nova Chip ultra thin hot mix seal. Minnesota DOT provided considerable assistance in designing the chip seal application rates. Researchers conducted a pre-construction condition survey, observed construction, and conducted a post-construction condition survey.

INTERIM GUIDELINES FOR TMS

After reviewing the literature and the results of the 1997 test sections, a set of preliminary guidelines was developed to assist transportation officials with TMS timing and selection. It is expected that these guidelines will be refined as additional performance information is obtained from the test sections.

Three-Step Decision Procedure

A three-step decision procedure is recommended (see flowchart, Figure 2). A detailed explanation of the tables is provided elsewhere *(4)*.

Step 1 - Collect information on candidate roads for thin maintenance surfaces. A performance survey should be conducted to assess the amount and type of distress that the road is suffering. The survey could be a detailed distress survey to provide input for PCI calculations. If a pavement management system is in place, the PCI has been calculated and tracked for a number of years. Thus additional helpful information regarding the rate of deterioration is available. At least a visual assessment should be made and rut depths should be noted. The traffic count should also be obtained and areas that must withstand many turning and stopping movements should be noted.

Step 2 - Identify feasible treatments. Using Table 1, identify feasible treatments. Table 2 provides additional guidance for selecting treatments for roads where rutting is the primary distress.

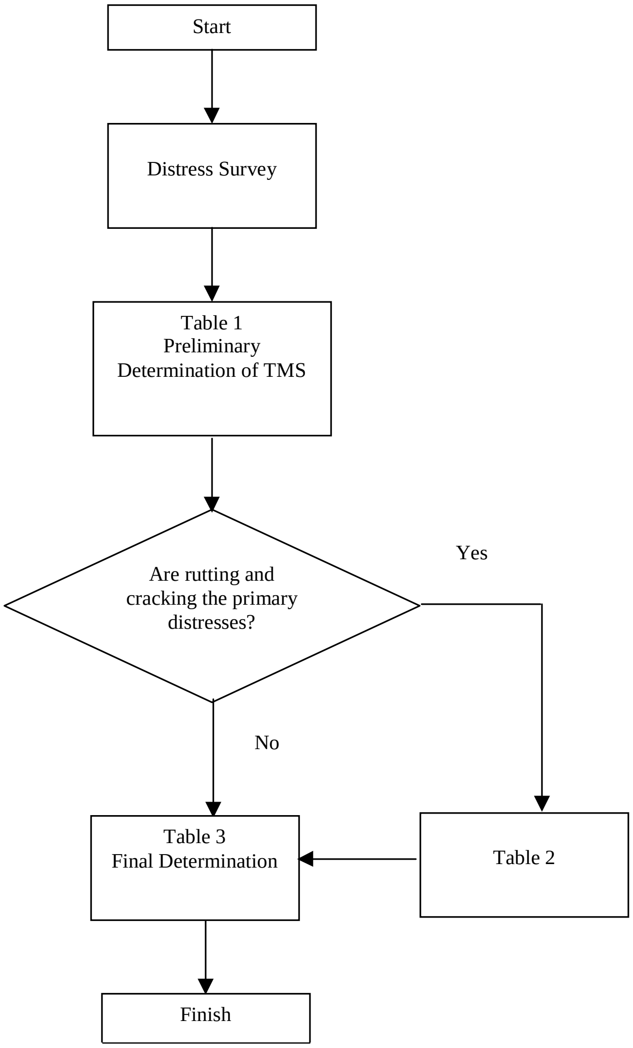

FIGURE 2 TMS selection flowchart (*4*)

Step 3 - Consider other factors before making a final selection. Table 3 provides a list of other factors that should be considered before making a final selection.

Timing

Properly timing the construction of TMS is extremely important. If the treatment is applied too soon, funds are being expended on roads that do not require treatment. If the treatment is applied too late, the road may have deteriorated to the point that TMS are ineffective. Most experts suggest that TMS be first applied to a road seven to 10 years after it is first constructed.

TABLE 1 Recommended Maintenance Strategies for Various Distress Types and Usage *(2, 4)*

	Seal Coat	Slurry Seal	Micro-Surfacing
1. Traffic			
ADT < 2000	R	R	R
2000 > ADT < 5000	M[1]	M[1]	R
ADT > 5000	NR	NR	R
2. Bleeding	R	R	R
3. Rutting	NR	R	R
4. Raveling	R	R	R
5. Cracking			
Few tight cracks	R	R	R
Extensive cracking	R	NR	NR
6. Improving friction	Yes	Yes	Yes[2]
7. Snow plow damage	Most susceptible	Moderately susceptible	Least susceptible

R = Recommended NR = Not Recommended M = Marginal [1]There is a greater likelihood of success when used in lower speed traffic [2]Micro-surfacing reportedly retains high friction for a longer period of time

TABLE 2 Selection Process for Medium and High Traffic Based on Rutting and Cracking *(3, 4)*

	Rut Depth			
Treatment	Less than ¼-in	¼ to ½ in.	½ to 1 in.	Greater than 1 in.
Micro-Surfacing[1]	One course	Scratch course and final surface	Rut box and final surface	Multiple placement with rut box
Slurry Seal[2]	One course	One course	Micro-surfacing Scratch course and final surface	See note 3

[1] As recommended by International Slurry Seal Association
[2] Current practice in Iowa
[3] Sometimes successful (anecdotal evidence)

CONCLUSIONS

The following conclusions were made:

- When properly selected, timed, and constructed, TMS can economically maintain the condition and extend the life of pavement surfaces.
- Good construction techniques and attention to detail are critical to the success of TMS.
- Warm weather is required for several days after application to properly cure emulsion products.
- If TMS are applied to roads that are in poor condition, they are likely to have a limited life.
- Roads should be first considered for TMS seven to 12 years

TABLE 3 Factors That Affect Maintenance Planners' Decisions *(2, 4)*

	Seal Coat (SC)	Slurry Seal (SS)	Micro-Surfacing (MS)
Past Practices	Most officials prefer not to change successful past practice unless there is definite reason for a change. These reasons could be positive or negative changes in funding, neighbor complaints, user complaints, or an opportunity to use better product.		
Funding and Cost	Least expensive option- less funding is required.	More expensive than SC and less expensive than MS.	Most expensive option- more funding is required.
Durability	Dependent on aggregate type, binder type, and application technique.	Less durable than micro-surfacing.	More durable than slurry seal.
Turning and Stopping Traffic	Can be flushed by turning and stopping traffic.	Can hold turning and stopping traffic.	Best wear in turning and stopping traffic.
Dust During Construction	Considerable dust possible.[1]	Little dust possible.	Little dust possible.
Curing Time[2]	Road can be opened after rolling is completed and speed should be limited to about 20mph for 2 hours.	Road can be opened after 2 hours in warm weather, and 6-12 hours in cold weather.	Road can be opened after 1 hour.
Noise and Surface Texture	Fairly noisy surface, open surface texture, and many loose rocks immediately after construction.	Less noise, dense surface texture (close to hot mix surface).	Less noise, dense surface texture (close to hot mix surface).
Availability of Contractors	13 contractors in Iowa.	3 contractors in Iowa.	2 contractors in Iowa.
Use of local Aggregates	Maximum flexibility - Can use somewhat dusty aggregates with cutback binder. - Can use emulsion or cutbacks. - Rock chips, pea gravel, and sand may be used.	Less flexibility.	Least flexible. The binder is highly reactive (break time is affected by clay content).

[1] Dust is mitigated by using washed, hard, or precoated aggregate.
[2] U.S. Department of Transportation, Federal Highway Administration.

after construction (when fine aggregate first starts to ravel).

- According to the literature, the expected life of a thin maintenance surface is between five and 10 years.

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