Quantitative Guidelines for Thin Maintenance Surfaces

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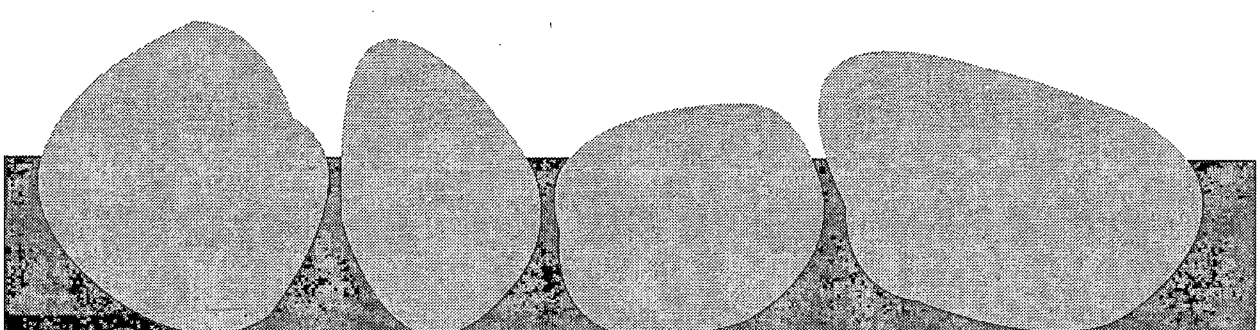

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The contents of this document are taken fro ... s:
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Introduction

What follows are the refined guidelines from the *Thin Maintenance Surface: Phase II Report*. For that report, test sections were created and monitored along with some existing test sections. From the monitoring and evaluation of these test sections, literature reviews, and the experience and knowledge of the authors, the following guidelines were created. More information about thin maintenance surfaces and their uses can be found in the above-mentioned report.

Phase Two Refined (Quantitative) Guidelines

The guidelines for thin maintenance surfaces proposed in the phase one project were qualitative (see "Qualitative Guidelines for Thin Maintenance Surfaces" brochure). An example of such a qualitative guideline is as follows: Slurry seal and micro-surfacing are not recommended for badly cracked pavements; however, those treatments can be used to address a small amount of light cracking. The judgment may vary between decision makers about what is a "badly cracked pavement" and what constitutes "a small amount of light cracking." Since no quantitative standards exist, a framework for guidelines that are more quantitative needed to be developed. This framework is based on the pavement condition index as described by M. Y. Shahin in his 1994 book, Pavement Management for Airports, Roads, and Parking Lots, and the first author's experience accumulated while executing both phases of the thin maintenance surface (TMS) research project. The result is a set of guidelines that could be improved with further research, but are more quantitative than the ones developed in phase.

The allowable quantity of each type of distress was selected by considering an appropriate Surface Condition Index (SCI) value for given treatments, traffic levels, and distresses. After the SCI level was selected, a permissible amount of distress was back calculated. Three levels of traffic were considered:

- **5,000 AADT.** This traffic level was considered because it is typical of a high volume, two-lane, rural primary highway that may be a candidate for conversion into a four-lane highway.
- **2,000 AADT.** This traffic level was considered because it represents a transition from a high volume primary rural highway to a low volume primary rural highway. Traditionally, Iowa DOT has had different maintenance practices for highways above and below this traffic level.
- **200 AADT.** This traffic level was considered because it represents a transition between rural roads that are usually paved to ones that are usually graveled.

The guidelines were developed with the expectation that users will use their judgment and interpolate or extrapolate to investigate treatment selection for a particular traffic counts. In general, treatments that are the most appropriate for particular types of distress will be recommended at lower SCI values than treatments that are less appropriate.

The guideline for cracks serves as an example. First, notice that the recommended SCI values for routine maintenance range from 60 to 95, for preventive maintenance range from 50 to 75, for rehabilitation range from 25 to 60 and for rebuilding range from 0 to 60 (Table 1). It is expected that a TMS will be used for preventive maintenance, so the expectation is that the SCI value will range from 50 to 75 at the time of treatment.

Table 1. SCI Values for Maintenance Activity Types

Maintenance Activity	SCI Value	Deduct Value
Routine	60–95	5–40
Preventive	50–75	25–50
Rehabilitation	25–60	40–75
Rebuilding	0–40	60–100

Table 2 was developed for four surface treatments (micro-surfacing, 1/4-inch seal coat, 1/2-inch seal coat, and double seal coat) and various crack lengths on a 24-foot-wide by 100-foot-long section of roadway. Crack lengths ranged from 300 to 1,500 feet in increments of 150 feet, except for a final 300-foot increment. SCI and deduct values were calculated as described by Shahin[1], with the assumption that light L&T cracking was the only distress present. Note that Shahin's method does not provide SCI calculations for L&T crack lengths that exceed 720 feet (30 percent distress). It may be that distress densities that exceed this amount are considered block cracking or some other type of distress in this method: no further explanation was found.

Table 2. Thin Maintenance Surface Guidelines Based on Amount of Cracking and Annual Average Daily Traffic

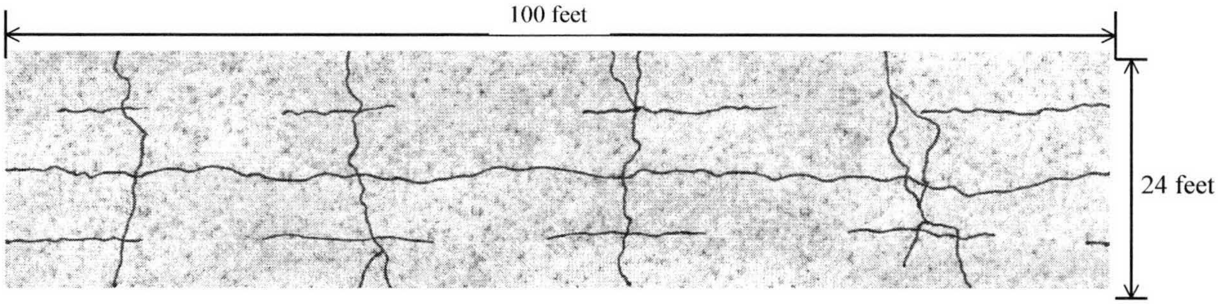
Feet of Cracking*	300	450	600	750	900	1,050	1,200	1,500
SCI basis**	80	78	73	71	***	***	***	***
Deduct basis**	20	22	27	29	***	***	***	***
	AADT							
Micro/slurry	5,000		2,000		200			
Seal coat (1/4 inches)		5,000		2,000		200		
Seal coat (1/2 inches)			5,000		2,000		200	
Double seal coat				5,000		2,000		200

Note: Based on 100 feet of road 24 feet wide.
* Medium intensity cracks require joint sealing or slurry strip repair before surface treatment is placed. Likely long-term result is two closely spaced light intensity cracks. Therefore, consider 1 foot of medium intensity crack equal to 2 feet of light intensity crack. High intensity cracks require patching before treatment is placed. The likely long-term result is two closely spaced light intensity cracks. Therefore, consider 1 foot of high intensity crack equal to 2 feet of light intensity crack. Utility cuts and patches are considered low intensity cracks around the perimeter of the repairs.
** Based on light L&T cracking.
*** SCI basis and deduct are not given for more than 750 feet of light L&T crack.

[1] Shahin, M.Y. 1994. *Pavement Management for Airports, Roads, and Parking Lots.* New York: Chapman & Hall.

For the purposes of these guidelines all cracks (except alligator cracks) are converted into an equivalent length of light cracking. Medium and heavy intensity cracks are considered to be equivalent to light density cracks at twice the length of the original crack. It is assumed that both types of cracks will be repaired before the treatment is placed: medium intensity cracks with joint sealer or slurry strip and high intensity cracks with patches. The likely result in both cases is two light intensity parallel cracks, one on each side of the repair. The perimeter of any patches or utility cuts is also considered to be the genesis of a light intensity crack.

The possible use of slurry seal or micro-surfacing was considered to establish a lower bound on the amount of cracking distress that would be addressed by thin maintenance surfaces. Since these techniques do not address cracking as well as other techniques, the required SCI is set somewhat above the usual preventive range at 80 (preventive range is 50–75) for high volume primary roads (AADT = 5,000). If light L&T cracking is the only distress, the maximum allowable percent of distress is 12.5 percent for a deduct value of 20. For a 100-foot section of road 24 feet wide (2,400 ft^2), the maximum allowable feet of length of cracking is 12.5 percent of 2,400 ft^2, or 300 feet. A road with four transverse joints in 100 feet, a completely cracked longitudinal joint at the centerline of road, and a partial (50 percent) crack in each mid-lane would yield slightly less than 300 feet of crack (Figure 1). In the principal investigator's experience, this represents a reasonable amount of cracking to be addressed by micro-surfacing on a high volume road.

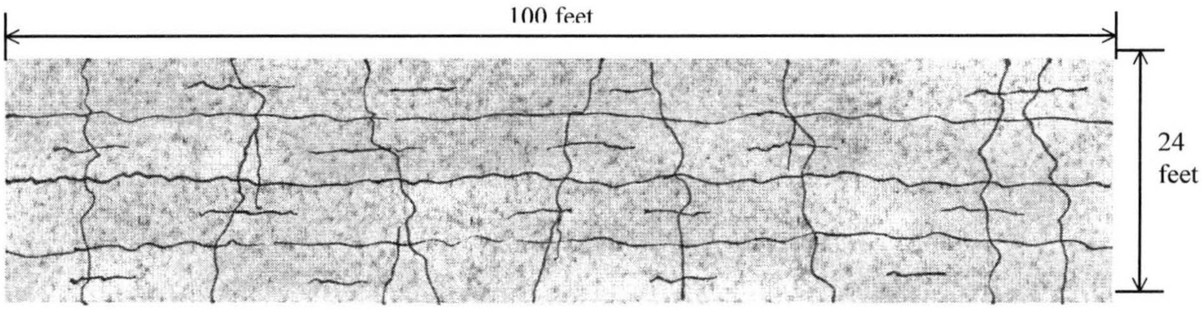


1 longitudinal joint	100 feet
50% crack at 2 mid-lanes	100 feet
4 transverse joints	96 feet
Miscellaneous	4 feet
Total	300 feet

Figure 1. 2,400 ft^2 Section of Roadway with about 300 Feet of Cracking

Table 2 indicates that if length of crack doubles, micro-surfacing would only be recommended if traffic is 2,000 or less AADT. This calculates to a SCI value of 73, which is inside the preventive range. Six hundred feet of crack could occur in a 100-foot section of 24-foot-wide road, if there are eight transverse cracks, the centerline and both mid-lanes were cracked and 25 percent of the wheel paths is cracked (see Figure 2). Although the start of wheel path cracks may suggest incipient fatigue failure, at 2,000

AADT, it is possible that the pavement may retain sufficient structural strength to last the life of the maintenance treatment—about seven years. Note that caution should be used when applying TMS to pavements that may be suffering fatigue failure, because TMS will do little to mitigate this failure. Note that for 600 feet of light intensity cracks on a higher volume road (5,000 AADT), 1/2-inch seal coat would be suggested, if the agency had a policy of seal coating such high volume roads.

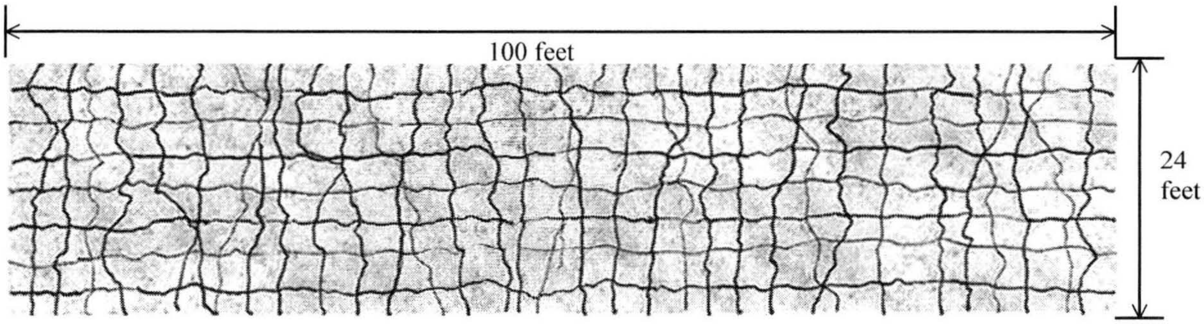


1 longitudinal joint	100 feet
2 mid-lane	200 feet
25% of 4 wheel paths	100 feet
8 foot × 24 foot transverse	192 feet
Miscellaneous	8 feet
Total	600 feet

Figure 2. 2,400 ft^2 Section of Roadway with about 600 Feet of Cracking

To establish an upper bound, for the amount of cracking distress that could be addressed with TMS, a 3 foot by 3 foot crack pattern similar to block cracking was considered (Figure 3) and a double seal coat was selected as a satisfactory treatment for roads with 200 or less AADT. This was selected on the basis of anecdotal evidence that the first author collected where a road with a similar crack pattern was successfully treated in this way. Note that the cracks could not be cracks that "work" under load and that the road may not meet the usual standards for ride and appearance. However, the treatment might successfully preserve a road with such light traffic.

Guidelines were also developed to address alligator cracking with TMS. Alligator cracking usually indicates that the pavement is experiencing a fatigue failure. Again, since TMS does very little to address fatigue problems, the strong possibility exists that the pavement will experience continued structural failure and an investment in preventive maintenance would be wasted. However, a TMS may reduce the amount of moisture entering the base and subgrade through the pavement, thus stiffening the subgrade and reducing pavement stress, which would provide modest benefit. Also, the principal investigator has anecdotal evidence that low volume roads, especially urban residential streets can also be candidates for thin maintenance surfaces, if they have light alligator cracking due to small deflection fatigue (the pavement may fail in fatigue after it has lost flexibility with age and has experienced many small fatigue cycles). For low volume road, the thin maintenance surface may be sufficient to "glue" the alligator blocks in place and reduce crack width so as to prevent spalling for a time.



3 foot × 3 foot crack pattern (similar to block cracking):		
7 longitudinal		700 feet
1 centerline	100 feet	
2 mid-lane	200 feet	
4 wheel paths	400 feet	
33 foot × 24 foot transverse		~800 feet
Total		1,500 feet

Figure 3. 2,400 ft^2 Section of Roadway with about 1,500 Feet of Cracking

Table 3 was developed to provide a guideline for using TMS for addressing alligator cracking distress. Thin maintenance surfaces are not recommended for a pavement that is experiencing medium or heavy intensity alligator cracking; any such areas that exist should be patched before the TMS is applied. Table 3 indicates that zero percent distress is allowed for medium and heavy intensity cracking and for roads with traffic volumes of 5,000 AADT. The SCI requirement for micro-surfacing and 2,000 AADT was set at 75, which is the upper limit of the usual range for preventive maintenance. Thus the maximum allowable alligator cracked area would be 5 percent. This was chosen because micro-surfacing/slurry seal is not a preferred treatment for addressing cracking distress. The required SCI for 2,000 AADT and 1/4-inch seal coat, 1/2-inch seal coat, and double seal coat are 70, 65, and 60, respectively, based on the principal investigator's judgment. For each treatment, compared to the requirement for 2,000 AADT, the SCI requirement is 10 points less for 200 AADT.

Table 3. Thin Maintenance Surface Guidelines Based on Amount of Alligator Cracking and Annual Average Daily Traffic

	Micro/Slurry			Seal Coat (1/4 inches)		
AADT	5,000	2,000	200	5,000	2,000	200
SCI basis	*	75	65	*	70	60
Deduct basis	*	25	35	*	40	50
Light cracking**	*	5%	12%	*	8%	1%
Medium cracking	*	***	***	*	***	***
Heavy cracking	*	***	***	*	***	***
	Seal Coat (1/2 inches)			**Double Seal Coat**		
AADT	5,000	2,000	200	5,000	2,000	200
SCI basis	*	65	55	*	60	50
Deduct basis	*	35	55	*	40	50
Light cracking**	*	12%	22%	*	18%	40%
Medium cracking	*	***	***	*	***	***
Heavy cracking	*	***	***	*	***	***

Note: Based on 100 feet of road 24 feet wide.
* TMS are not recommended to address any alligator cracking on roadways with 5,000 or greater AADT.
** Applies to alligator cracking caused by fatigue due to advanced age combined with moderate deflection on firm subgrade. Do not use TMS for fatigue cause by severe deflections on soft subgrade.
*** TMS not recommended for medium or heavy alligator cracking.

Bleeding is the last type of distress for which guidelines were refined (Table 4). Separate guidelines were developed for slurry seal and micro-surfacing. The minimum SCI requirement for 5,000 AADT and micro-surfacing was set at 80, while for the same traffic and seal coat, the SCI was set at 60. As traffic decreases, 10-point increments are allowed between each category. The SCI requirement was set high for micro-surfacing and slurry seal because it is difficult to change the mix design to use less binder to compensate for bleeding from the substrate. For seal coat, a SCI requirement of 60 was selected because the amount of binder can be adjusted downward to compensate for bleeding. The SCI of 60 is near the middle of the preventive maintenance range (Table 1). If seal coat is used, the chances of success can be increased by using one-size aggregate that will allow excess void space to accommodate additional oil from the bleeding surface. Compared to smaller sized aggregate, larger sized aggregates will provide more void space for excess oil.

Table 4. Thin Maintenance Surface Guidelines Based on Amount of Bleeding and Annual Average Daily Traffic

	Micro/Slurry			Seal Coat*		
AADT	5,000	2,000	200	5,000	2,000	200
SCI basis	80	70	60	60	50	40
Deduct basis	20	30	40	40	50	60
Light bleeding	100%	100%	100%	100%	100%	100%
Medium bleeding	23%	55%	100%	100%**	100%**	100%**
Heavy bleeding	8%	15%	25%	25%**	40%**	60%**