National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

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Surface Condition Rating System for Bituminous Pavements

An NCHRP staff digest of the essential findings from the final report on NCHRP Project 10-9, "Criteria for Need of Seal Coats on Bituminous Pavements," Prepared by E. L. Skok and M. S. Kersten, University of Minnesota, Minneapolis, Minn.

THE PROBLEM AND ITS SOLUTION

Seal coats (surface treatments) have generally been accepted as the most economical method of maintaining bituminous-surfaced pavements in serviceable condition. As a result, decisions must be made by highway agencies with regard to the programming of seal coats. Maintenance personnel are frequently responsible for determining what roads should be sealed during a given season. A decision to prematurely seal a road will result in needless expenditure of funds. A decision to defer sealing of a road that is in need of a seal coat may result in excessive deterioration or unsafe conditions and greater eventual expenditures. Currently used methods for determining the need of a seal coat rely on the judgment of experienced personnel and thus are quite inadequate for general use. A need exists for practical methods and criteria to assist in seal coat programming for bituminous pavements.

The University of Minnesota researchers have reviewed methods for seal coat programming used by various highway agencies, developed a Surface Condition Rating System to aid highway agencies in seal coat programming, and field tested the procedure in several states. The developed procedure is practical in that it is based on standardized visual observations and, except for measurement of pavement skid resistance where applicable, no special equipment or highly skilled personnel are required. It contains photographic examples of various rating levels and is thus adequately documented for immediate implementation. Field testing of the System in five states provides substantial assurance that it can be effectively used by maintenance personnel.

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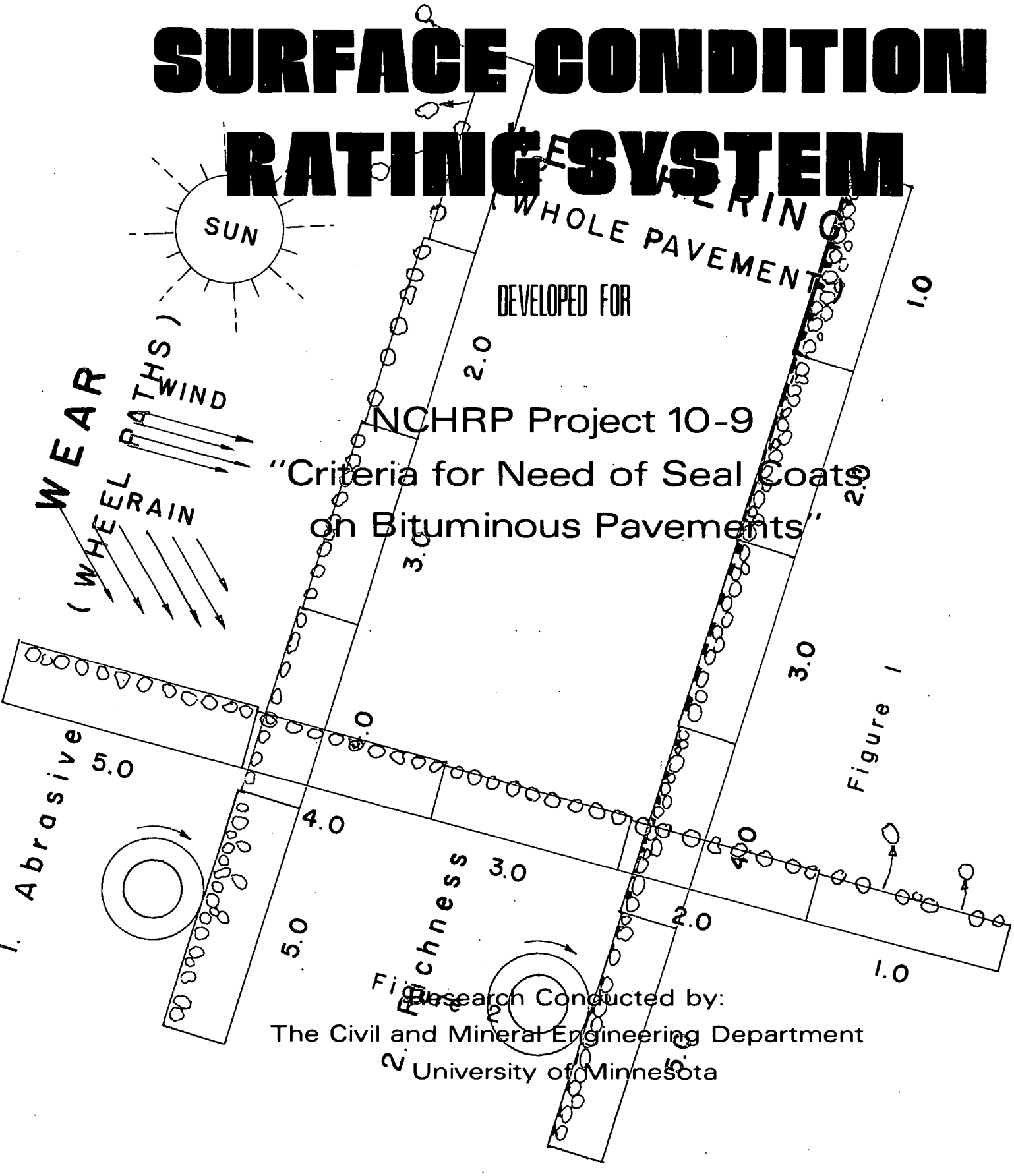
FINDINGS

The essential product of this study is the Surface Condition Rating System fully described in the attachment to this Digest. The System consists of a surface rating form that is to be completed for each section of road being considered for a seal coat and complete instructions for use of the form. To aid in its use, photographs and descriptions of each rating level for each item to be rated are included, as well as a completed sample form.

APPLICATIONS

At present, the judgment of experienced highway personnel is the primary basis for developing seal coat programs. The experience and judgment of personnel is likely to vary significantly between jurisdictions, and even within a jurisdiction, resulting in less than most effective use of the limited funds available for maintaining bituminous pavements in serviceable condition. The Surface Condition Rating System developed under Project 10-9 can help to alleviate this problem by being utilized as a training aid for less experienced personnel and to encourage more uniformity in the rating of surfaces with regard to the need for a seal coat. In addition, the System suggests criteria for seal coat programming, to be used with the surface rating information, that can be adopted as given or adapted to individual highway agency needs.

SURFACE CONDITION RATING SYSTEM



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SURFACE CONDITION RATING SYSTEM*

INTRODUCTION

In order to most economically maintain bituminous-surfaced pavements in serviceable condition, applications of seal coats may be periodically required. The determination of the need for seal coats, the type required, and the proper time to apply is important. Premature sealing results in a needlessly early expenditure of funds, while tardy action may result in excessive deterioration or unsafe conditions and greater total maintenance expenditures. Currently available methods of rating pavements for the need of sealing are not totally adequate. They are time consuming, require the use of costly equipment and highly skilled personnel, rely on judgment of experienced personnel, or are not reproducible. Methods and criteria for determining when seal coat applications should be made are needed.

The purpose of this project has been to develop criteria for the need of seal coating bituminous surfaces. These criteria were to be based on relatively simple methods, such as visual evaluation of pavement surfaces or the use of measuring devices or equipment. In establishing the methods of evaluating surfaces and criteria for sealing, various types or classes of bituminous surfaces have been distinguished. Also, the types have been classified. So-called low-type bituminous surfaces have been emphasized and seal coats by definition include only those resurfacings with a thickness of ¾ in. or less; this includes thin plant-mix seals. (Attention is directed to HRB Circular No. 73 for classification systems.) The criteria for determining the need for a seal coat will differ for various types of bituminous pavements and for the use of different types of seals. The criteria also indicate where other remedial measures should be used.

The following approaches have been used:

1. Information has been obtained and evaluated on criteria and methods in use by agencies at the present time.
2. Tentative criteria for the need of seal coats have been developed.
3. After the tentative criteria and rating methods were developed, they have been field tested to some degree by seeing how usable the rating system is and how repeatable it is.
4. An outline of an experimental program for use by other agencies to evaluate the criteria and methodology has been developed.
5. The criteria have been modified somewhat based on the field tests. An attempt is being made to set up the criteria and associated methodology in a form suitable for inclusion in maintenance manuals.
6. A training session has been developed which can be used to train highway personnel to use the surface rating devised as part of the criteria for when to seal coat a pavement.
7. The training session has been presented in five states to see whether the surface rating system can be made workable using the training aids. The reproducibility and consistency of rating made by the people in the states has been checked and used to determine if, in fact, it is workable.

* Prepared as Appendix D of the final report for NCHRP Project 10-9, "Criteria for Need of Seal Coats on Bituminous Pavements."

SURFACE CONDITION RATING SYSTEM

BACKGROUND

The condition of a pavement section can be best described by, first of all, considering the causes of and the amounts of various types of deterioration. In order to make decisions on what type of maintenance is appropriate for a given road, the pavement condition should be defined in terms of 1) how well the pavement rides, 2) the structural condition of the pavement, and 3) the surface condition of the pavement. The alignment or sufficiency should also be considered in an over-all evaluation. If any one of these factors reaches a low level, something must be done to the pavement. The decision of what to do should depend on the level of the other factors. For instance, if the pavement rides poorly, an overlay must be put on the surface. How much of an overlay to be put on should be dependent on how strong the pavement is, which is part of the structural condition of the pavement. A pavement maintenance system should include each of the factors, and the decision of when and what to do should be based on the level of each condition.

The ride of a pavement has been well defined using various measurements to calculate a serviceability rating. Many agencies are now using this approach, which was originally developed at the AASHO Road Test. The structural condition can be estimated using either a condition rating approach or a strength measuring device such as the Benkelman beam, Dynaflect device, or the road rater—all of which measure the deflection of the pavement under given loading conditions. Some agencies are using both a condition rating and strength measurement to evaluate the structural condition.

The other condition which should be considered relative to maintenance criteria is the surface condition of a given pavement. The surface condition will, again, give an indication of when something needs to be done to improve the surface, but what to do can only be determined by considering the surface condition along with the rideability and structural condition.

RATING SYSTEM

The purpose of this presentation is to define a surface rating system that can be used to define specific levels of surface condition. The items considered for this rating system are listed on the rating sheet shown as Figure 1. This form provides a check list for the factors used for the surface rating system. The different factors are kept separate because their causes are different and essentially independent. For instance, the progression of weathering could occur with no surface wear at all, and, therefore, to combine these two effects would result in a confounding of the evaluation system.

The causes of any type of pavement deterioration relative to rideability, structural condition, or surface condition can first be separated into those which are traffic associated and those which are non-traffic associated. Traffic associated distress can generally be observed in the wheelpath, whereas non-traffic-associated distress can be generally observed across the pavement and be most significant between the wheelpaths.

For instance, stresses in a pavement due to traffic loading will result in patterned cracking in the wheelpaths, whereas transverse cracks which may ultimately progress to block cracking of a whole pavement surface are the result of temperature and/or moisture changes within the pavement section.

Also, bleeding usually is observed in the wheelpath and thus is assumed to be due to traffic. It will, therefore, be treated in this category when considering the surface condition.

The term "surface wear" is used to define conditions which are traffic associated, and the term "weathering" is used to define surface conditions which are non-traffic associated.

During the presentation of the surface rating system, an attempt is made to describe various *stages* or *degrees* of deterioration.

To help define the numerical ratings, each even digit of the various types of deterioration is given the following description, which defines the respective level or degree of deterioration:

Rating	Degree
5	NONE
4	SLIGHT
3	MODERATE
2	SEVERE
1	DETERIORATED

Most rating schemes which have been developed in the last few years use a higher numerical rating to describe a better condition; thus, a rating of 5.0 has been assigned to a "no deterioration" level and 1.0 to a condition which is at a quite serious level or completely deteriorated relative to the condition being considered.

For instance, when a pavement is stressed due to traffic loading, distress may first show up as a longitudinal crack in the wheelpath, which is not as serious as the case where there is patterned or block cracking. Map or block cracking, in turn, is not as serious as when the cracking develops into a smaller grid or alligator cracking. In order to be able to represent these different conditions rather than writing various descriptive terms for each, it would be more convenient to be able to use a number to represent each condition. In this way, a number can represent the condition of the pavement at a given time. By keeping track of these ratings with time (year to year), it could then be possible to monitor how fast the pavement is breaking up.

FIGURE 1

SURFACE CONDITION RATING FORM

Date_____

Job Description_____

Surface Sealed Before ☐ Yes ☐ No

	GEN. STR. CONDITION	SURFACE WEAR	WEATHERING	SKID RESISTANCE	UNIFORMITY	CRACK CONDITION			
						OPENING	ABRASION	MULT.	
		☐ Excess Asphalt		Skid Number					
5	Good	None	None	Coarse / Good / Gritty	Good	Hairline	None	None	5
						1/16			
4	Long Crk.	Slight	Slight	Coarse / Fair / Gritty	Strkd.		Slight	Slight	4
						1/8			
3	Map Crk.	Moderate	Moderate	Agg. Sl. Pol.	Cr. Fill.		Moderate	Moderate	3
						1/4			
2	Allig Crk.	Severe	Severe	Agg. Pol.	Blotchy		Severe	Severe	2
						1/2			
1	Eros.	Abrasion	Erosion	Bleeding	Non Unif.	> 1/2	Abrasion	Erosion	1

For example, if the pavement were allowed to break up due to traffic-associated loading without repairing it, it might go through the following steps:

New pavement, good condition, no cracks.

Cracking beginning to develop as longitudinal cracks in wheelpath.

Large pattern of cracks developed (map cracks).

Pattern smaller (alligator cracks).

Small pieces of pavement are thrown out by traffic (erosion).

In this way, the deterioration of a pavement can be described in terms of load-associated cracking by listing the steps it will probably go through from a new pavement to a point where (with no maintenance) it will be literally destroyed and the investment in the surfacing will be completely lost. If one could overlay or treat the pavement when it was in one of the stages before alligatoring or breaking up, it might have been possible to save the surface.

To facilitate describing the conditions of load cracking, listed numbers could be used. Generally, a higher rating has been used to denote a better condition for other rating systems developed. Thus, a pavement with no cracking would be given a General Structural Condition rating of 5. The other conditions listed could then be given ratings of 4, 3, 2, and 1, respectively. Therefore, a pavement which had alligator cracking along a significant portion of the wheelpath would be given a rating of 2.0, etc.

In terms of when something should be done to the pavement, certainly nothing would be done at a rating of 5.0. However, some initial maintenance may be considered at 4.0 and more work would be considered if the rating dropped to 3.0 and more so at a rating of 2.0. If nothing was done at a rating of 2.0, it might drop to 1.0 and a whole new surface would have to be built. These conditions are listed in the first column under General Structural Condition on the rating form.

As a pavement goes through the steps of deterioration with respect to load cracking, it may (most likely) never show only one of the conditions given ratings of 5.0 through 1.0, respectively. There may be both map and alligator cracks. This would occur as the alligator cracking develops from map cracking. To describe this condition, a general estimate of the relative amounts of each could be made and a rating between 2.0 and 3.0 be used. For instance, if there was about one-half of each type estimated, then a rating of 2.5 would be appropriate.

The pictures in Figure 2 show pavements at different levels of general structural condition.

The condition of the pavement along the whole length of the road must also be considered. A "representative" rating along the length should be the goal of any rating procedure. How long a length of road to consider will depend on the relative conditions and the type of maintenance being considered. This is dependent on both the amount of money available and past experience in that area.

The conditions a pavement might go through as it cracks due to wheel loads (traffic associated) can be described as illustrated. Any other type of pavement deterioration can also be defined in this way if the *stages* of deterioration can be determined. The stages or degrees of deterioration might be defined. Numerical ratings could then be given to the various stages or degrees. For instance, permanent deformation or rut depth due to wheel loads could also be evaluated in this way. However, this would most likely be related to the depth of rut, which is already a number and thus no great advantage would be realized by converting to a rating system.

For the remainder of this presentation, an attempt is made to define the *surface* condition of a bituminous pavement. A rating of *general structural condition* in terms of observable cracking has been considered. The structural deterioration can be thought of as being a result of the *weight* of axle loads to go over a given pavement or section (flexure or compression). This would bend or crush the pavement surface.

The condition of the surface can be thought of as deteriorating because of abrasion or scraping by tires or as general deterioration due to Mother Nature's elements, such as the sun, water, and wind. In general, the effects due to wheels (wear) can be observed in the wheelpaths (if they can be defined), as shown in Figure 3. The effects due to nature (weathering) can generally be observed between the wheelpaths or across the whole pavement section width, as shown in Figure 4. Sometimes there may be a lesser effect due to weathering in the wheelpath because of the kneading action of tires. When considering the effects due to weathering, one should, generally, look *between* the wheelpaths for the most serious condition.

When considering wear or weathering, the pavement surface will look different and show deterioration in a somewhat different way, depending on whether the surface is the original bituminous mat or whether it has been seal coated. The condition of the seal coat becomes an important consideration for a surface that has been seal coated.

There are, therefore, four conditions used to define the surface condition relative to wear and weathering on a bituminous pavement. These are:

1. Wear no seal coat.
2. Wear with seal coat.
3. Weathering no seal coat.
4. Weathering with seal coat.

In addition to these characteristics, the surface condition is further defined considering *skid resistance, uniformity,* and *crack condition.*

SURFACE WEAR

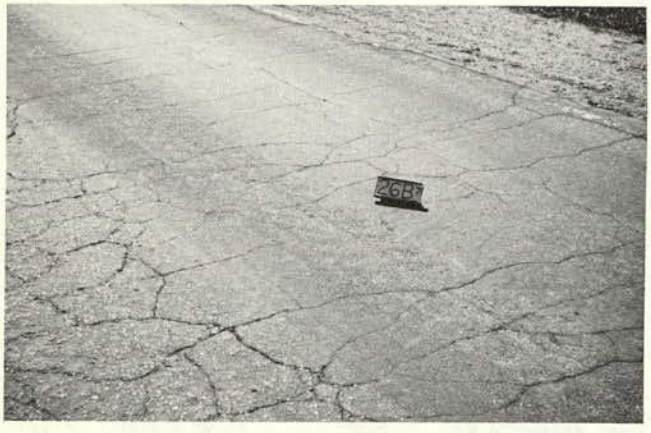
As mentioned previously, wear is defined as deterioration due to the abrasive action of tires on the sur-

FIGURE 2

EXAMPLES OF GENERAL STRUCTURAL CONDITION RATINGS

A pavement with longitudinal cracking in the wheelpath (Rating 4.0)

A pavement with longitudinal cracks beginning to connect (Rating 3.5)



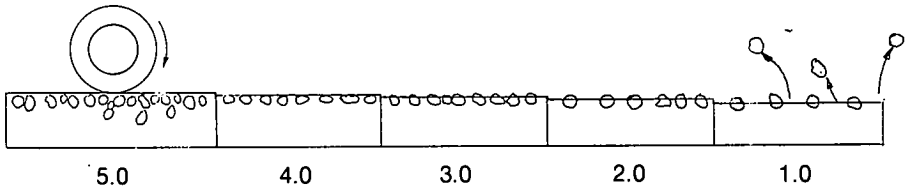
A pavement with map or block cracking in wheelpath (Rating 3.0)

A pavement with alligator cracking in wheelpath (Rating 2.0)

FIGURE 3

PROGRESSION OF "WEAR" OF A BITUMINOUS SURFACE (WHEELPATHS)

1. Abrasive



2. Richness

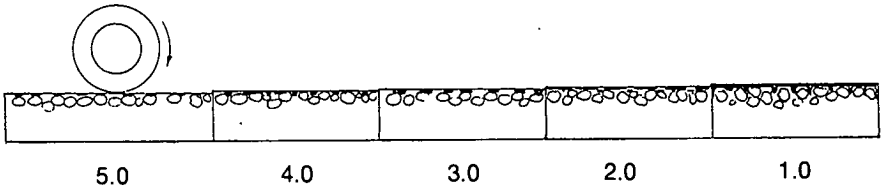
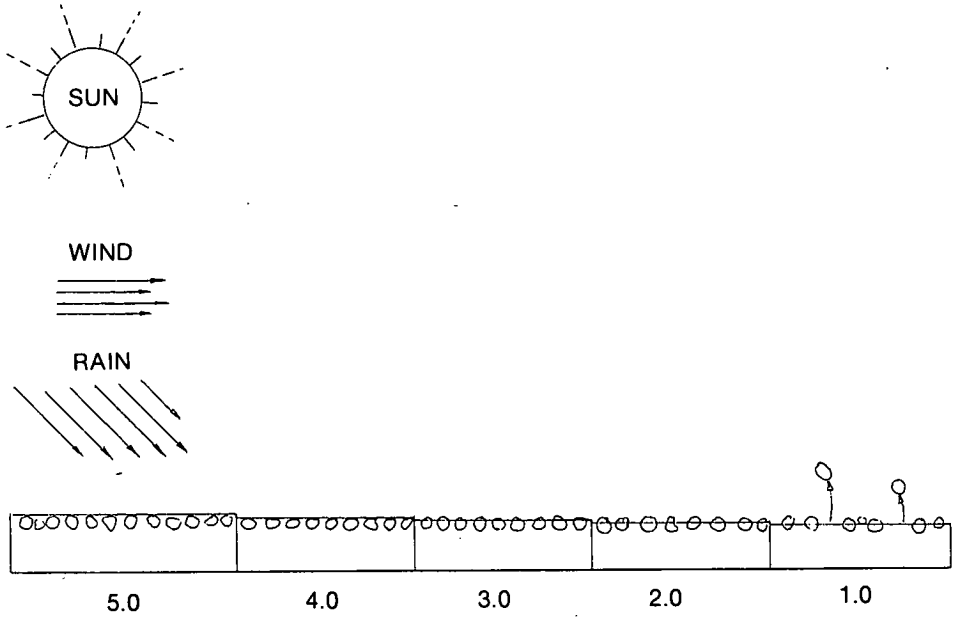


FIGURE 4

PROGRESSION OF "WEATHERING" OF BITUMINOUS SURFACE (WHOLE PAVEMENT)



face. Based on recent research, it can be said that studded tires would tend to increase the rate of this type of deterioration. Wear, as generally thought of, shows as either:

1. Exposure and a protrusion of the coarse aggregate due to eroding away of the sand matrix of the asphalt mixture, or
2. Wearing down of the coarse and fine aggregate at about the same rate in the wheelpath causing a uniform longitudinal depression or rut in the wheelpath.

The first case, which is most prevalent, occurs when relatively hard coarse aggregates are used for the asphaltic surface mixture. The second would occur when softer coarse aggregates have been used. The deterioration in the second case is a deepening of the rut depth in the wheelpath.

For the case when there is relatively hard coarse aggregate and a condition exists whereby the surface will tend to wear down, the following levels of deterioration can be observed in the wheelpaths:

1. The new surface is uniform across the pavement, both in the wheelpath and between.
2. The color and outline of the coarse aggregate shows in the wheelpath more than between, indicating that the asphalt has worn off the aggregate surface.
3. The coarse aggregate protrudes up to 1/16 in., indicating that the sand matrix or mortar is being kicked out or worn away by the tire action.
4. The coarse aggregate protrudes more than 1/16 in., indicating that the sand matrix has continued to be kicked out, making the coarse aggregate susceptible to be abraded out by additional tire action.
5. More than 20 percent of the coarse aggregate is kicked out in the wheelpath, indicating that the sand matrix has been so eroded that it can no longer hold the coarse aggregate.

For the last condition, the surface has deteriorated to the point where significant quantities of the surface have been eroded away, which could cause weakening and destruction of the pavement.

The conditions described have been used as the basis of a rating system, as indicated in Figure 1. The descriptive terms are added in Table 1 to help illustrate the condition.

There may be, of course, all levels of conditions between those described. These intermediate conditions can be indicated numerically by using ratings such as 2.6 or 3.4, to the nearest 0.1.

Figure 5 shows examples of some of the levels of surface wear due to abrasion of a pavement surface that has not been seal coated.

Another action of tires on a pavement is that of pumping asphalt to the surface of the pavement, eventually causing a "bleeding" condition. This action has been classified under traffic-associated conditions because it is caused by tire action and can be observed in the wheelpaths. It would occur in pavements that have relatively higher asphalt contents than those on which wearing away or abrasion of the surface would be observed.

The descriptive terms in Table 2 have been used to indicate the *degree* of this phenomenon, which could be called a progression of bleeding. Again, the terms none, slight, moderate, and severe can be used to indicate this progression.

The pictures in Figure 6 show pavements at various levels of bleeding according to this rating system.

When considering the surface wear column on the rating sheet, the rater must first indicate if this pavement shows an excess of asphalt or not. This will then indicate whether he is rating the development of *abrasion* or of the degree of *bleeding* in the wheelpaths.

If a bituminous surface has been seal coated and been covered with an aggregate, or is originally a surface treatment rather than an asphaltic mix, the descriptions presented for abrasion are modified slightly. The descriptions listed in Table 3 can be used to describe the degrees of abrasion on a bituminous pavement that has been seal coated and has a cover aggregate on it.

TABLE 1

RATING FOR LEVELS OF PAVEMENT SURFACE WEAR (ABRASION) WITH NO SEAL COAT

Rating	Degree	Description
5	None	Mat uniform and original color across surface.
4	Slight	Coarse aggregate shows in wheelpath but not protruding.
3	Moderate	Coarse aggregate shows in wheelpath and protrudes up to 1/16 in. or wheelpath is worn down up to 1/16 in.
2	Severe	Coarse aggregate protrudes in wheelpath more than 1/16 in., or mat is worn down more than 1/16 in.
1	Abrasion	More than 20 percent of coarse aggregate is kicked out in the wheelpath.

FIGURE 5

EXAMPLES OF SURFACE WEAR FOR PAVEMENTS
NOT PREVIOUSLY SEAL COATED AND WITH WEAR
NOT ASSOCIATED WITH EXCESSIVE ASPHALT

A relatively new plant-mix overlay with the aggregate showing more in the wheelpath, but not protruding. (Rating 4.2)

An unsealed surface mix with the coarse aggregate showing and protruding less than 1/16 in. in wheelpath. (Rating 3.5)

An unsealed surface mix with the coarse aggregate showing and protruding 1/16 in. and more in some cases. (Rating 2.5)

A surface which has worn in the wheelpath to the extent that the coarse aggregate is being kicked out. (Rating 1.0)

FIGURE 6

EXAMPLES OF SURFACE WEAR FOR PAVEMENTS NOT PREVIOUSLY SEAL COATED AND WITH WEAR ASSOCIATED WITH EXCESS ASPHALT

A chip seal in which the asphalt is filling the surface between the seal aggregate but has not covered the aggregate. (Rating 3.0)

A chip seal which is just starting to get rich in the wheelpath. However, the aggregate still shows and protrudes. (Rating 4.0)

A condition where asphalt has bled up over aggregate or aggregate has been eroded off, leaving excess asphalt. (Rating 2.0)

TABLE 2

RATINGS FOR LEVELS OF PAVEMENT SURFACE WEAR (BLEEDING)

Rating	Degree	Description
5	None	Mat uniform and original color across surface.
4	Slight	Surface dark in wheelpath due to mix appearing richer in wheelpath.
3	Moderate	Bituminous material filling surface in wheelpath over 25 percent of length.
2	Severe	Surface richer and bleeding somewhat along more than one-half of the length in wheelpath.
1	Bleeding	Wheelpath rich and bleeding along entire length of pavement.

TABLE 3

RATINGS FOR LEVELS OF SURFACE WEAR (ABRASION) WITH SEAL COAT

Rating	Degree	Description
5	None	Surface uniform original color of seal coat across the surface.
4	Slight	Color lighter in wheelpath.
3	Moderate	Up to 25 percent of seal coat aggregate kicked out in wheelpath.
2	Severe	Seal coat aggregate eroded away, showing original surface in the wheelpath.
1	Abrasion	Aggregate from original surface being kicked out in wheelpath.

When the original surface is exposed, the rating should be of the original mat, because it is, again, exposed to the tire and climatic elements as it was before being resurfaced. Figure 7 shows some examples of abrasion surface wear on pavements that have been seal coated.

Again, when making a rating of these conditions, if a particular surface appears to fall between the descriptions listed, an intermediate rating should be used. The nearest 0.1 can be used to more accurately estimate the condition if necessary.

In summary, pavement surfaces can be broken down into three categories for purposes of rating relative to surface wear or tire action on a pavement wheelpath.

Tire action can cause either abrasion (eroding out) of surface material or bleeding (excess asphalt) on the surface. When either of these conditions gets to a low enough rating, some type of resurfacing is necessary.

When judging the degree of abrasion, the observable items will be somewhat different, depending on whether the surface has been previously seal coated or not.

Before making the wear rating, the rater must indicate what situation he is rating.

1. Abrasion, no seal.
2. Abrasion, seal.
3. Bleeding.

This information will indicate what type of corrective measures are appropriate, along with which descriptive ratings to use to judge the degree of deterioration.

WEATHERING

Thus far, deterioration of a pavement surface that can be associated with tire *abrasion* on the surface or with tire *pumping* action, which both show as surface distress in the wheelpaths, has been considered. In addition to these effects, there is observable deterioration due to heat, water, and wind on the pavement. These factors will act on the pavement uniformly across the surface, barring protected areas. However, the most critical areas with respect to weathering will most likely be between the wheelpaths, because in some cases the kneading action of tires has been shown to improve the surface drying out caused by weathering. Generally, the rater should, therefore, consider the pavement surface *between* the wheelpaths when making a rating for weathering. Again, the degree of weathering must be judged somewhat differently, depending on whether the surface is the original bituminous mixture, or if it has been seal coated with an aggregate topping.

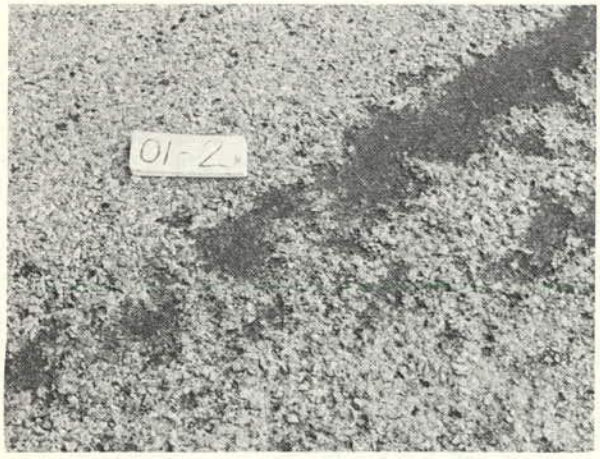
Table 4 is a list of the descriptions of the degree and ratings suggested for the weathering of pavement surfaces which no *not* have a seal coat cover aggregate.

FIGURE 7

EXAMPLES OF SURFACE WEAR FOR PAVEMENTS PREVIOUSLY SEAL COATED AND WITH WEAR NOT ASSOCIATED WITH EXCESSIVE ASPHALT

A chip seal with 100 percent of the surface covered with seal aggregate. (Rating 5.0)

A chip seal with between 10 and 20 percent of the seal coat aggregate kicked out in the wheelpath. (Rating 3.5)



A chip seal with over 25 percent of the seal coat aggregate kicked out in the wheelpath, but bituminous material still covering original mat. (Rating 2.5)

A sand seal worn off and original mat aggregate showing almost the entire length of road. (Rating 2.0)

TABLE 4

RATINGS FOR LEVELS OF WEATHERING
(PAVEMENTS WITH NO SEAL COAT)

Rating	Degree	Description
5.0	None	Bituminous surface original color except possibly in wheelpath.
4.0	Slight	Surface is color of surface aggregate, especially between wheelpaths.
3.0	Moderate	Coarse aggregate protrudes between wheelpaths.
2.5	Checked	Random small cracks beginning to form, mostly between wheelpaths.
2.0	Severe (Cracking)	Random cracks developed into a pattern or blocks (not related to loading).
1.0	Erosion	Coarse aggregate or chunks of surface being eroded out.

The cracking observed relative to weathering is caused by shrinkage or drying out of the mat, which should occur uniformly across the surface or be more predominant *between* the wheelpaths. The condition in this regard may not be as serious in the wheelpath because the tire action might actually decrease the drying out effect.

Figure 8 shows various levels of weathering of a bituminous mixture that has not been seal coated.

For a pavement surface that has been seal coated with an aggregate or is originally a surface-treatment-type construction, the drying out of the surface shows up in somewhat different ways.

Table 5 is a list of the descriptions of the ratings and degrees of weathering for a bituminous surface that has been covered with seal coat aggregate or is a surface-treated pavement.

If the condition of the seal coat on a bituminous mix is such that the original surface is exposed (which occurs at a rating of about 2.0), a rating of the original surface should be made. It may be found that even if the seal coat has worn off the original mat may not need an additional treatment. Figure 9 shows some of the levels of weathering of a surface treatment or seal-coated surface.

In summary, to evaluate the degree of weathering a pavement surface has undergone, the surface is first classified as to whether (1) it is a bituminous mixture that has not been seal coated, or (2) it is a bituminous surface that has been seal coated with cover aggregate or is a surface-treatment type surface. The indications of weathering can generally be observed between the wheelpaths, whereas wear, which was considered previously, can be observed in the wheelpaths.

For any given pavement surface, one rating should be given for wear and one for weathering unless the rating on a seal-coated pavement is so low that the original surface is being rated. In that case, two ratings would be shown and the higher of the two would almost always be that of the original surface.

OTHER SURFACE CONDITIONS

In addition to general structural condition, wear, and weathering, the following characteristics can also be used to define the surface condition of a pavement:

Skid resistance.

Uniformity.

Crack condition.

Of these, the skid resistance is the only one that would be of primary importance in terms of setting up seal coat criteria. In fact, skid resistance should, generally, be considered above wear and weathering because of safety considerations.

Uniformity of texture and color should be subordinate to the other three characteristics because it has to do with appearance, which is not directly related to safety or loss of investment. However, if funds are available for resurfacing of a pavement which rates low on appearance, it may be appropriate to do so for public relations purposes.

Crack condition ratings could be used to determine if other types of surface maintenance might be appropriate before or instead of a seal coat. The considerations and methods of rating these characteristics are presented so that as complete a picture as possible of the surface condition can be presented in rating form, which will give the maintenance engineer enough information for making decisions with respect to surface maintenance.

SKID RESISTANCE

If the skid resistance of a pavement is low, causing a significant increase in accidents, something must be done to the surface of the pavement no matter what the other indicated surface conditions are. The low skid resistance may be due to an excess of asphalt on the surface of the pavement or may be due to polishing of the aggregate surfaces.

FIGURE 8

EXAMPLES OF WEATHERING OF A BITUMINOUS PAVEMENT NOT PREVIOUSLY SEAL COATED

A bituminous mat which is the color of the aggregate between the wheelpaths because the bituminous material has been eroded off of the aggregate and the aggregate does not protrude. (Rating 4.0)

A bituminous mat in which the sand matrix is beginning to erode away between the wheelpaths exposing the coarse aggregate and making it protrude. (Rating 3.0).

The start of random shrinkage cracking associated with weathering of the bituminous mat. (Rating 2.5)

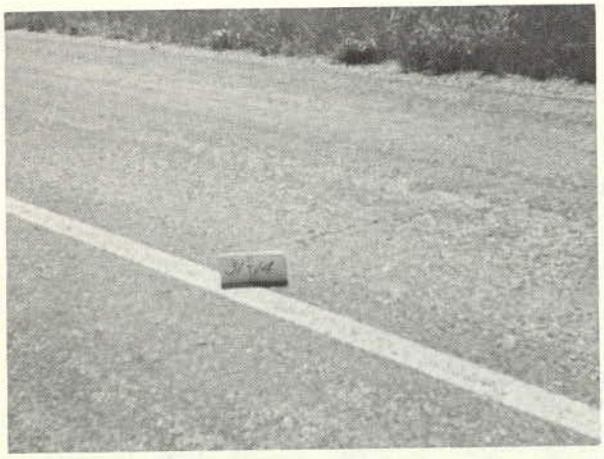
The development of random cracking in block patterns. (Rating 2.0)

FIGURE 9

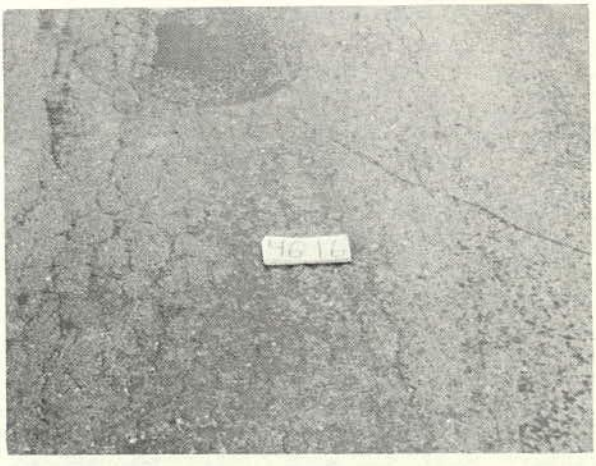
EXAMPLES OF WEATHERING OF A BITUMINOUS PAVEMENT PREVIOUSLY SEAL COATED WITH A COVER AGGREGATE

The area between the wheelpaths of this pavement appears slightly drier between the wheelpaths and a few particles have been eroded off. (Rating 4.0)

A chip seal with between 10 and 50 percent of the seal coat aggregate worn off between the wheelpath on the lane to the right. (Rating 3.0)



A seal coat with more than 50 percent of seal aggregate eroded off across the pavement and only bituminous material covering the mat. (Rating 2.0)



A seal coat with more than 50 percent of seal aggregate eroded off across the pavement and distress in original mat showing through. (Rating 1.5)

TABLE 5

RATINGS FOR LEVELS OF WEATHERING OF PAVEMENTS WITH A SEAL COAT OR SURFACE TREATMENT

Rating	Degree	Description
5	None	Seal coat aggregate intact and in condition as constructed.
4	Slight	Seal coat aggregate appears "drier" between wheelpaths (up to 10 percent eroded off).
3	Moderate	10 percent up to 50 percent of seal coat aggregate eroded off (both wheelpaths).
2	Severe	Seal coat aggregate is more than 50 percent eroded off between wheelpaths, leaving only bituminous material covering the original surface.
1	Erosion	Seal coat is essentially all eroded off and the original surface is beginning to erode.

TABLE 6

RATINGS FOR LEVELS OF SKID RESISTANCE BASED ON VISUAL EXAMINATION

Rating	Description
5	Good, coarse surface texture.
4.5	Good, gritty surface texture.
4	Fair, coarse surface texture.
3.5	Fair, gritty surface texture.
3	Aggregate slightly polished or wheelpath slightly darkened with excess asphalt.
2	Aggregate polished or wheelpath darker due to excess asphalt.
1	Bleeding condition.

A number of agencies now have skid trailers that make it possible to obtain a measure of the skid resistance by a physical test yielding a number that could be used to rate the pavement. However, there is little unanimity of thought at what level of skid number a pavement should be resurfaced. It is hoped that with the amount of work being done in this field more universal criteria based on skid number measurements eventually can be developed.

If a usable system employing a skid meter has not been developed by an agency, a rough visual measure of skid resistance is suggested using the descriptions listed in Table 6. There is no sure way of describing the level of roughness for each rating. The only way is to observe the relative skid resistance of many pavements and thereby establish experience as to the ordering of the levels of skid resistance.

The descriptions of coarse and gritty are only general in nature. If coarse aggregate and fine aggregate are slightly exposed at the surface and would be in contact with the tires, the coarse description is used. The "good" rating is used when the exposed aggregate is relatively angular, and the "fair" rating is used when the aggregate is more rounded in nature. The "gritty" description refers to a sandy texture which, again, would be classified as "good" if the particles were angular and "fair" if the particles were more rounded.

The aggregate "slightly polished" and "polished" refer to the condition when a sheen starts to develop on a relatively hard aggregate due to the scrubbing action of tires. This would not be as bad as a bleeding condition (rated 1) because of the greater likelihood of hydroplaning on a bleeding pavement.

The actual range of skid resistance as measured by a skid trailer would probably overlap the descriptions presented. However, if reliable criteria have not been developed based on the skid number, the descriptive ratings can be used to give at least a general indication of this condition of the surface.

TABLE 7

RATINGS FOR LEVELS OF UNIFORMITY OF TEXTURE AND COLOR

RATING	Description
5	Good
4	Streaked
3	Crack-filling
2	Blotchy
1	Multiple spot patching

UNIFORMITY

One of the reasons given for seal coating a pavement has been to cover up a pavement that looks bad because a great deal of maintenance patching and spot sealing has been done on the surface. The ratings and descriptions for this condition are given in Table 7.

A streaked appearance is generally due to non-uniform application of a seal coat binder.

When cracks are filled, the filler is usually darker than the rest of the surface and shows up when one looks down the road.

The blotchy and very blotchy conditions are the result of a number of different applications of spot seals and overlays to correct previous structural or surface deterioration.

A rating of this condition is made by making an overview of the road, rather than by looking at one particular spot.

CRACK CONDITION

The final factor that is used to define the surface condition of a pavement is the condition of the longitudinal and transverse cracks. The ratings presented in this section can be used to evaluate the effectiveness of crack fillers, in addition to seal coats, to improve the crack condition.

The condition of the cracks is broken down into three divisions:

1. Opening.
2. Abrasion or erosion.
3. Multiplicity.

Crack opening refers to how open the crack is all the way through the surface mixture. If the top of the crack is worn back, this additional erosion is not added to the amount of opening. Abrasion or erosion relates to the amount of wearing back of the crack at the surface, and multiplicity refers to how much additional cracking is associated with the cracks. To represent the opening and abrasion conditions, ratings and descriptions are given in Tables 8a and 8b, respectively.

The multiplicity associated with transverse or longitudinal cracks may be due to brittleness of the surface mixture and lack of continuous support of the surface, plus weakening of the underlying material because of infiltration of water into the crack. To represent multiplicity conditions, ratings with descriptions are given in Table 8c.

Figures 10a, 10b, and 10c show various degrees of opening, erosion, and multiplicity, respectively.

Just as for the ratings discussed earlier, there are possibilities of all phases of ratings from one degree to another. In order to cover these variations, ratings to the nearest 0.1 between those listed should be used.

SUMMARY

In summary, to define the surface condition of a bituminous pavement, the degree or level of the following conditions are defined:

1. General structural condition.
2. Wear, no seal.
   Surface treatment or sealed.
3. Weathering, no seal.
   Surface treatment or sealed.
4. Skid resistance.
5. Uniformity.
6. Crack condition.

Each of these conditions is listed on the surface condition rating sheet (Figure 1). The appropriate ratings can be checked off across the sheet.

The general structural condition refers to the deterioration of the pavement in the wheelpaths due to the traffic loading.

For wear and skid resistance, reference is made to the surface condition of wheelpaths, whereas for the other conditions the surface is rated over-all and the most critical area is considered to be between the wheelpaths relative to abrasion of the surface.

Wear can show as wearing down of the wheelpaths due to abrasion of just the sand matrix or of the whole mixture. The condition of excess asphalt in the wheelpaths, or bleeding, has also been defined as a condition of wear.

TABLE 8

a. DESCRIPTIONS OF RATINGS FOR TRANSVERSE AND LONGITUDINAL CRACK OPENING

Rating	Description
5	Hairline or filled
4	1/16 to 1/8 in. open
3	1/8 to 1/4 in. open
2	1/4 to 1/2 in. open
1	More than 1/2 in. open

b. DESCRIPTIONS OF RATINGS FOR TRANSVERSE AND LONGITUDINAL CRACK ABRASION OR EROSION

Rating	Degree	Description
5	None	No wearing back of cracks.
4	Slight	Slight wearing of edges (mortar).
3	Moderate	Some coarse aggregate eroding out.
2	Severe	Crack eroded back 1/2 way through the surface mix.
1	Abrasion or erosion	Eroded more than 1/2 way through the surface mix.

c. DESCRIPTIONS OF RATINGS FOR TRANSVERSE AND LONGITUDINAL CRACK MULTIPLICITY

Rating	Degree	Description
5	None	No associated cracks.
4	Slight	A few associated random hairline cracks.
3	Moderate	Map cracks developed, along with transverse and longitudinal cracks.
2	Severe	Alligator cracks developed, along with transverse and longitudinal cracks.
1	Erosion	Multiple cracks have broken away from surface.

The degree of weathering also is defined somewhat differently, depending on whether the surface is an original bituminous mat or if it has been seal coated or is a surface-treatment-type pavement. Examples have been presented to illustrate various degrees of wear and weathering as defined.

A very general rating system has been presented for skid resistance. Because of the difficulty of rating this condition by qualitative observation, it is suggested that a quantitative measure of skid resistance (such as obtained with a skid trailer) be used to evaluate this condition. The system presented herein should be used if a skid number measurement is not.

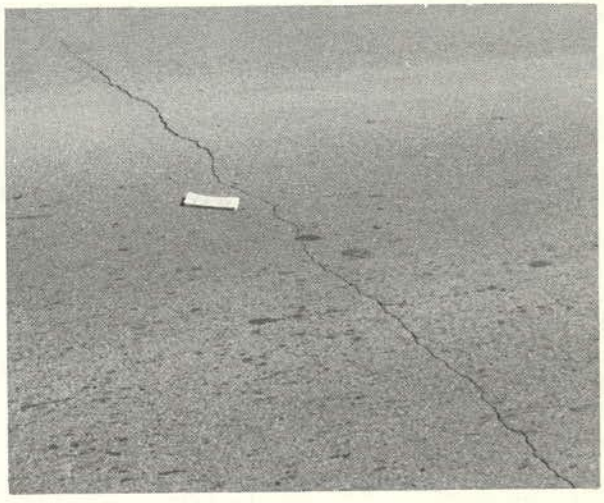
The condition of uniformity is also defined by degree with ratings. These items are not considered as important as wear, weathering, and skid resistance, but do help to define the condition of the surface.

The criteria for when a seal coat or, more generally, resurfacing is necessary are presented in the report. With regard to seal coating, the surface wear, weathering, and skid resistance are considered to be most significant. The condition level, in terms of a rating at which a resurfacing is required, is dependent on such things as the amount of funds available and whether an agency has a relatively conservative or liberal maintenance policy. (That is, whether they would rather

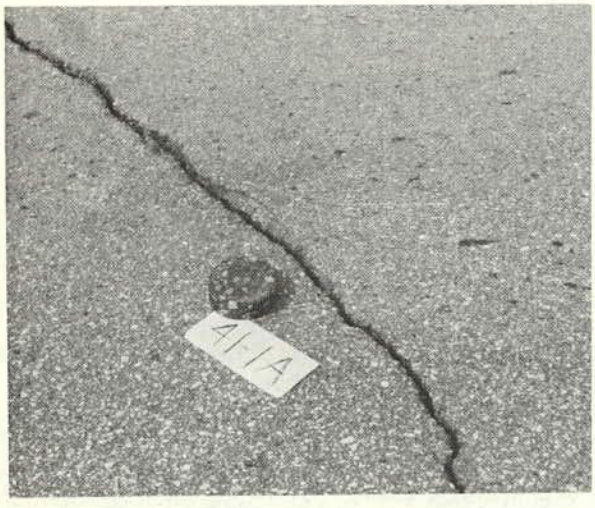
FIGURE 10a

EXAMPLES OF CRACK CONDITION RATINGS
OPENING

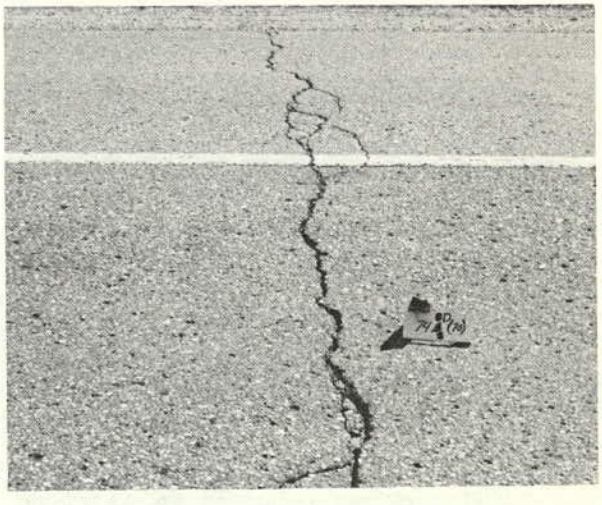
A hairline crack that is not open at all. (Rating 5.0)



A crack open 1/16 in. to 1/8 in. (Rating 4.0)



A crack open about 1/4 in. to 1/2 in. (Rating 2.0)

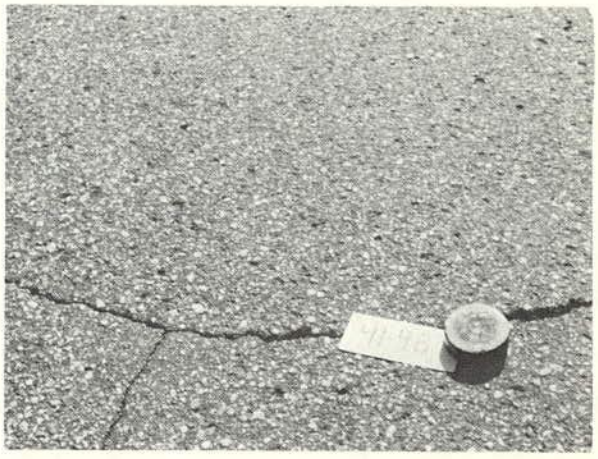


A crack open more than 1/2 in. (Rating 1.0)

FIGURE 10b

EXAMPLES OF CRACK CONDITION RATINGS
ABRASION

Slight abrasion of a crack, which refers to wearing back of the sand matrix. (Rating 4.0)



Moderate abrasion of a crack, which refers to wearing back, including some coarse aggregate particles eroded out. (Rating 3.0)

Severe erosion of a crack, which means that it is eroded more than one-half the way through the mat. (Rating 1.5)

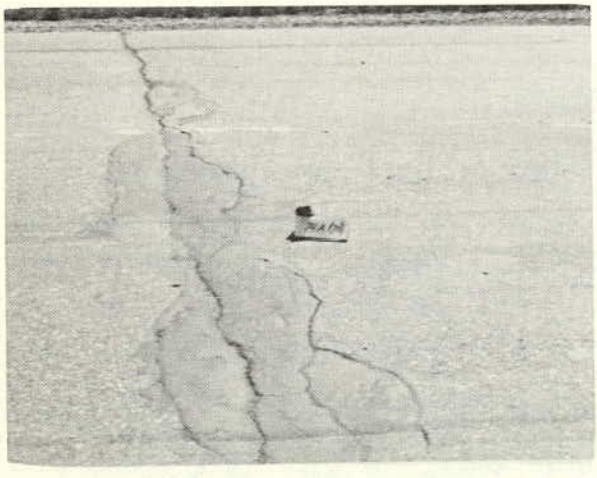
A crack that has been abraded all the way through the mat. (Rating 1.0)

FIGURE 10c

EXAMPLES OF CRACK CONDITION RATINGS
MULTIPLICITY

A crack that is not multiple. (Rating 5.0)

A crack that is "slightly" multiple; i.e., there are some associated cracks. (Rating 4.0)



The same crack, which has progressed to moderately multiple; i. e., the associated cracks have formed into a block pattern. (Rating 3.5)

A crack that has progressed to severe multiple and actually slightly worse because some places are beginning to erode out. (Rating 1.5)

maintain the road while it is in rather good condition or not.) It is felt that there would be no need of surface maintenance if the wear and weathering rating were 3.0 or higher. Also, if the rating is below 2.0, some type of surface maintenance is definitely required. These levels will vary somewhat, depending on materials and traffic in a given area. These levels will also be very dependent on the amount of money available for maintenance.

EXAMPLE

Figure 11 shows a copy of the rating form with ratings marked, and written out for clarity. First, it is important to include the date and the location of the pavement being rated so that the ratings can be referenced properly. The proper box must then be checked indicating whether the surface is an original surface mix or if it has been seal coated. If the pavement is a surface treatment, it should be checked as a seal coated pavement because the conditions described for wear and weathering would be the same as for a seal coated pavement.

The general structural rating for this pavement is 4.2, which means that some slight longitudinal cracks are beginning to appear. This means that the pavement is in good structural condition. Therefore, it does not need to be overlaid because of its structural condition. If a strength test were run it might be found that the pavement should be overlaid to strengthen it for the predicted traffic throughout the design period.

The conditions that have been shown to be helped by a seal coat over a period of time are surface wear, weathering, skid resistance, and uniformity. If any of the first three are less than 3.0, some form of seal coating should be considered. In this example the surface wear rating is the only one that is below 3.0 and thus some type of maintenance should be considered. The excess asphalt box has not been checked; therefore, the surface wear is of the abrasion type. Whether to do something at this level is further tempered by the amount of traffic, availability of funds, philosophy of maintenance, etc. For instance, if the traffic is very high some type of maintenance should be performed. However, it may be better to use a plant-mix seal coat or a structural overlay. The decision of what to do should also be tempered by how fast the given rating has gone down. For this example it was found that the surface wear rating was 2.8 the previous year. Therefore, because it has decreased by 0.4 in one year, the decision to seal coat is made. The type of coat depends on the traffic, funds, climate, and local experience.

The crack condition ratings are shown to complete the evaluating of the surface condition. The crack condition ratings can help indicate which pavements have cracks that need attention the most. The effectiveness of crack-filling or other types of treatment can also be determined. In this example the cracks are in relatively good condition.

It is recommended that individual agencies consider running a test program to establish what levels of condition are appropriate for seal coat criteria. The effectiveness of a seal coat in improving the surface condition ratings over a period of time can be determined by setting up test sections on projects to be seal coated. One section should be seal coated, and the other should be a no-seal section on the same project. The effectiveness of the resurfacing would then be determined by the relative condition of the sealed and no-seal sections. The surface condition rating system can also be used to monitor the condition of all the roads in a highway system. These ratings, along with ratings for rideability, structural condition, and strength, can then be used to establish maintenance criteria not only for seal coats, but also for overlays or other types of maintenance.

FIGURE 11

SURFACE CONDITION RATING FORM

Date 8/15/72

Job Description US 505, Nowhere to Somewhere, U.S.A.

Surface Sealed Before ☐ Yes ☑ No

	GEN. STR. CONDITION	SURFACE WEAR	WEATHERING	SKID RESISTANCE	UNIFORMITY	CRACK CONDITION		
						OPENING	ABRASION	MULT.
		☐ Excess Asphalt		Skid Number				
5	Good	None	None	Coarse / Good	Good	Hairline	None	None
	4.2			Gritty	4.4	1/16		
4	Long Crk.	Slight	Slight	4.0 Coarse / Fair	Strkd.	4.0	Slight	4.0 Slight
			3.6	Gritty		1/8	3.6	
3	Map Crk.	Moderate	Moderate	Agg. Sl. Pol.	Cr. Fill.	1/4	Moderate	Moderate
		2.4						
2	Allig Crk.	Severe	Severe	Agg. Pol.	Blotchy	1/2	Severe	Severe
1	Eros.	Abrasion	Erosion	Bleeding	Non Unif.	> 1/2	Abrasion	Erosion

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