SHRP-H-380

Making Pavement Maintenance More Effective

Training Supplement

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Texas A & M University

Engineering Research Institute
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Contents

Abstract

This report is a training supplement for material in *Pavement Maintenance Effectiveness (SHRP-H-358)* and *Development of a Procedure to Rate the Application of Pavement Maintenance Treatments (SHRP-H-322)*. This report suggests some immediate improvements in current pavement maintenance techniques such as chip seals, slurry seals, crack sealing in asphalt pavement; and undersealing, and joint and crack sealing in Portland Cement concrete pavements. Researchers also request that highway maintenance departments continue to track and log pavement maintenance data.

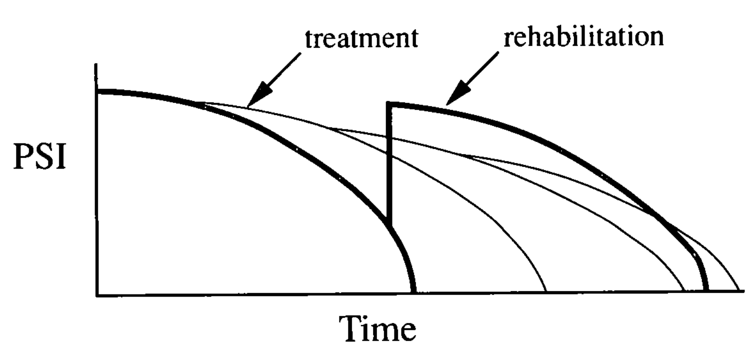
INTRODUCTION

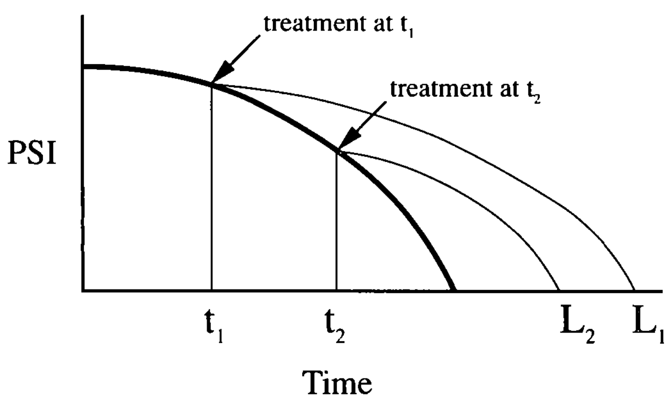
This document is intended to be a training supplement to material contained in the Final Report on Project H-101, Pavement Maintenance Effectiveness, *and in* Development of a Procedure to Rate the Application of Pavement Maintenance Treatments, Report No. SHRP-M/FR-92-102, *Strategic Highway Research Program. While conducting the research, the project staff identified three areas of concern, which are presented here to assist organizations in improving their pavement maintenance through better use of maintenance treatments. The project research included: chip sealing, slurry sealing, crack sealing, and thin overlays on flexible (asphaltic material) pavements. For rigid (Portland Cement Concrete) pavements, the research included crack and joint sealing and undersealing.*

The major topic discussed in this report is the "lessons learned" about the maintenance treatments. Since the project included test sections installed across the United States and Canada, it allowed a group of knowledgeable engineers and researchers to observe and compare design, application, and monitoring across the continent. This is being used to determine the factors that influence the quality of the maintenance treatments.

The second section of this report presents important considerations for continuing the development of a strong pavement maintenance database that was begun in SHRP H-101. Over the past several decades, some agencies have had disappointing experiences with maintenance treatments. Other agencies have developed rigid policies about applying some maintenance treatments. The initial data coming in from test sections covering the continent suggest that it will be more cost-effective to apply preventive maintenance treatments throughout the life of a pavement rather than to allow the pavement to deteriorate until major rehabilitation is needed.

The conceptual figure at right shows, in the heavy line, the present serviceability index (PSI) of a pavement from initial construction as it decays and then is restored to its original (or very nearly so) PSI through a major rehabilitation, such as a major structural overlay. Initial data from the test sections through the end of the initial research suggest that if modest-cost surface treatments are applied at the right time in the decay cycle, the PSI can be extended out in a very gradual decline over a much longer time, as shown by the light lines in the figure above. Thus, applying modest-cost surface treatments at the right time can delay the need for future major rehabilitation. This will save money in the paving budget. It may also save in the high cost of longer traffic delays and increased accidents that major reconstruction work zones often produce.





The initial data from observing the test sections started in SHRP H-101 also suggest that the pavement life will be extended longer if a particular maintenance treatment is applied before significant deterioration has set in, rather than waiting until the pavement has deteriorated badly. The figure to the left shows the type of increased life the initial research suggests that early surface treatment will provide as compared to applying the maintenance treatment later.

The test sections built with the cooperation of the Federal Highway Administration, numerous United States state departments of transportation, and several Canadian provincial departments of transportation, included maintenance treatments applied to sections at several stages of deterioration. Data have been collected for several years, but it is important that all test sections be preserved and monitored to failure (including the no-maintenance control sections) to develop reliable estimates of the treatment effect curves. If the data collection continues to failure on the maintenance test sections, future analysis of the database that has been started will produce reliable estimates of the cost-effectiveness of the treatments. This will significantly increase our ability to get the most pavement life for our dollars spent!

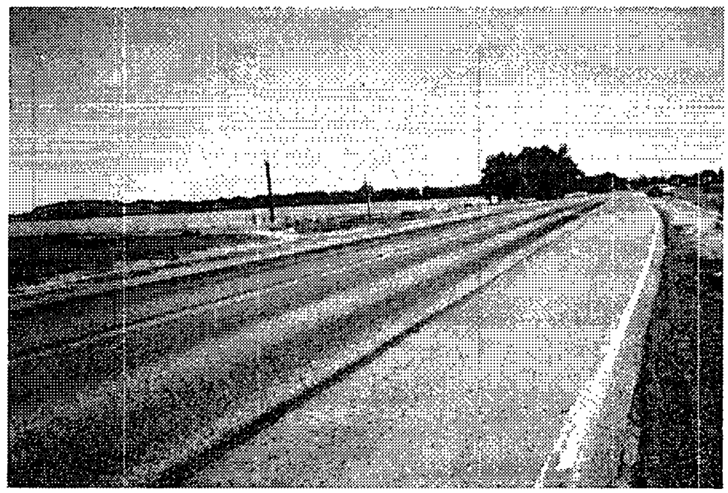
LESSONS LEARNED

Experiences gained by the research team during the construction of the treatments may be of help and interest to highway agencies. The following points are intended to provide maintenance supervisors and maintenance agencies with hands-on insights gained by the research team in carrying out the SHRP H-101 project across the United States and Canada. These points should be taken as information shared among peers who are primarily interested in doing a better job of pavement maintenance. If a point or comment provided here does not appear to apply to your organization or your organization's operations, consider it as a piece of knowledge that is interesting to know. However, if a point shared here seems to apply to your organization, you are encouraged to investigate it further in your quality circles, in your group meetings, or staff discussions. Any of these topics of interest should be discussed with personnel at all levels where any impact may be possible to improve pavement maintenance.

The points and discussion that follow are organized into the specific maintenance treatment areas that were studied in SHRP H-101. However, some of the observations noted under a specific treatment may be applicable to other treatments; in all cases, these points should be reviewed in the context of an agency's practices and methods to determine how and to what degree each may be useful. Each agency is encouraged to begin thinking of each maintenance treatment applied as a "test." By building a record of the conditions under which each treatment was applied and by monitoring the success of the treatment, you may determine the importance and impact of these points for your local conditions and local methods.

CHIP SEALS—Engineering Factors

• No uniform design is used for chip seals. A balance between aggregate and asphalt needs to be estimated and maintained throughout the chip seal application. Applying too much aggregate for the amount of asphalt needed to seal the pavement surface is as bad or worse than not applying enough. Likewise, putting down too much asphalt for the surface condition is as bad or worse than not applying enough asphalt. Some agencies do not regard a chip seal as a treatment that can be designed. Research into the design of chip seals has not yet agreed upon a single best procedure.

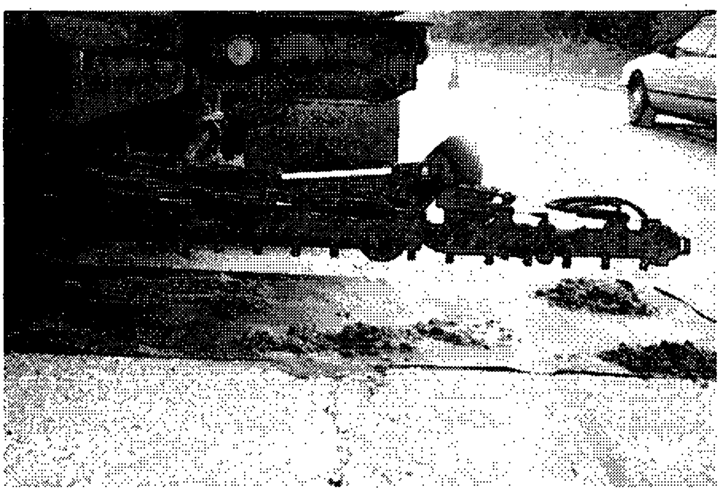


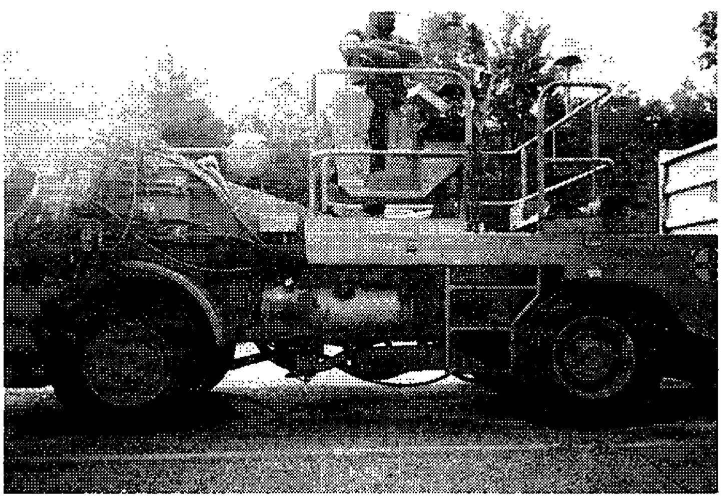
• The embedment of aggregate into the underlying surface should be included in chip seal design to help identify surfaces that should not be treated with a chip seal and to help determine the appropriate size of stone to use. Existing surfaces that allow too much embedment will lead to flushed surfaces when the stone embeds into the existing surface and below the asphalt binder. Smaller aggregates may be more susceptible to this than larger aggregates.

• Application specifications should include ambient upper temperature limits in addition to lower temperature limits for chip seals that use emulsified asphalt cement binders. Overheating the emulsified asphalt cement binders can reduce the seal performance.

• The type of pavement surface over which the seal coat is to be placed needs to be considered. Open-graded surfaces (sometimes referred to as "popcorn mixes") require significantly more asphalt to provide an effective seal than do surfaces that were originally constructed from dense-graded mixes. In some cases it may be necessary to apply a fog seal to the open surface before the chip seal binder is applied.

• The surface moisture condition of the aggregate chips affects the seal performance. Chips with a slightly damp surface seem to work better with emulsified asphalt cement binders than chips that are either completely dry or have a wet surface.





Equipment Factors—*Asphalt Distributor*

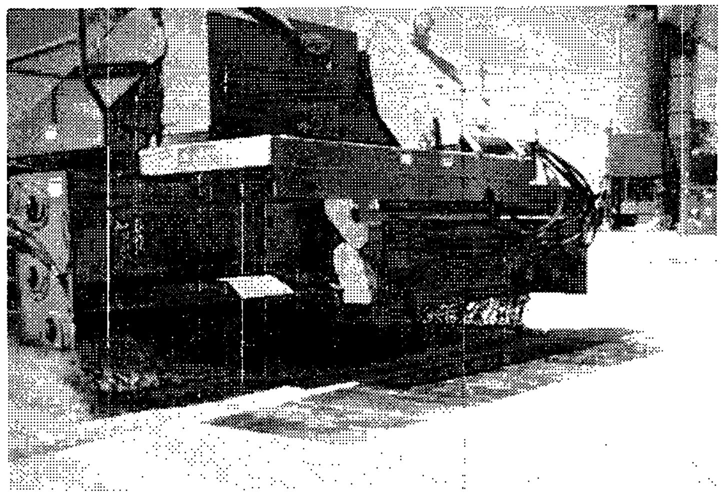
◦ Asphalt distributors are not currently being calibrated for transverse application rate. This must be done. The current ASTM procedure for asphalt distributor calibration is laborious and needs to be simplified. Agencies that wish to consider an alternate transverse calibration method are encouraged to investigate the British "road tray method," which is described in Road Note 39, *Recommendations For Road Surface Dressing*, Transport and Road Research Laboratory, UK (1981).

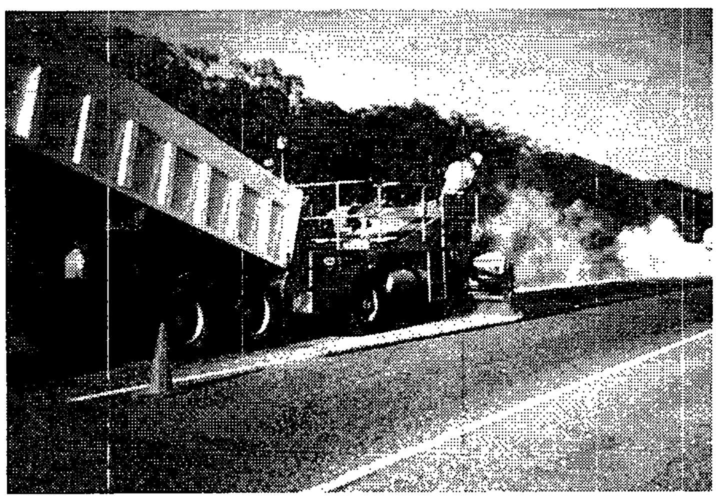
• When pavements have significantly different levels of surface texture in the wheel paths than between the wheel paths, the chip seal performance will be improved if the asphalt is applied at a different rate in the wheel paths than between the wheel paths. Different size nozzles can be used across the spray bar to accomplish this.

Chip Spreader

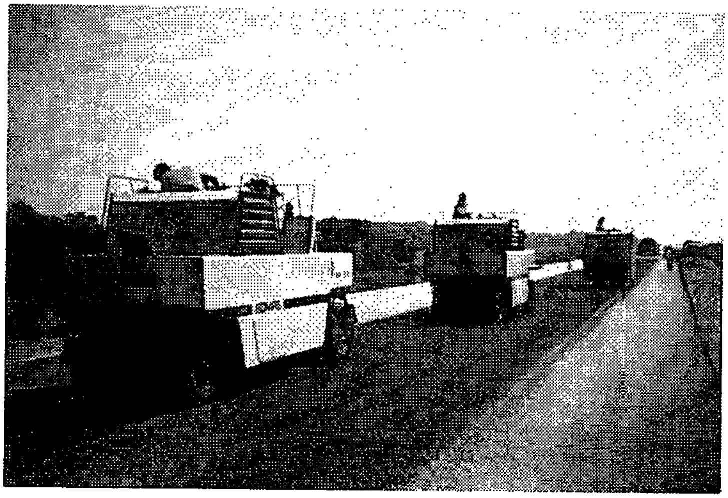
◦ Chip spreaders that kick the aggregate backward or drop the aggregate straight down reduce aggregate rollover and reduce the degree to which the aggregate picks up on vehicle tires after the section has been opened to traffic. This spreader is a variable width spread machine. One half of the width has a plate that kicks the aggregate forward and the other half has a plate that kicks the aggregate backward. The aggregate that is backward falls vertically with very little horizontal velocity. Therefore, it does not roll when it strikes the asphalt surface. The half of the chip spread that is kicked backward generally has a better cover pattern and is picked up less by tires than the half of the chip spread that is kicked off the forward-facing plate.

• Chip spreaders are not routinely being calibrated for either the longitudinal rate of chip application or the transverse rate of application. This must also be done. Rubber mats or plywood squares can be placed across the spread for a short distance along the travel path of the spreader. Chips are then spread over the mats or squares. The chip quantity on each mat or square is measured. Knowing the quantity of chips per area unit at each location provides a measure of the consistency of chip spread across the spreader and also in the direction of travel. This type of calibration is being placed in an ASTM standard test procedure that should be published shortly.





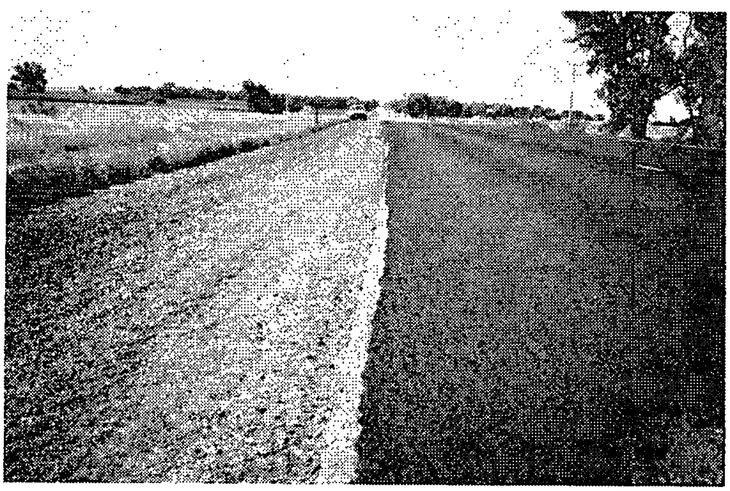
• It is important to observe any effect that the truck dumping chips into the spreader box has on the consistency of the spreader operation. It was observed that for some combinations of truck and spreader, when the truck bed was elevated to about 70 degrees, the chip spreader would bounce up and down as it traveled down the road. Although this effect occurred for only a short interval of time, it was enough to leave a rough, washboard strip that bothers drivers, contributes to chips being picked up, and creates a potential for damaging windshields. For certain combinations of truck and spreader, it appears that the downward force from the truck bed and the aggregate combine with the forward movement force of the spreader to make the power train and the suspension system react unevenly at least until the chips being loaded into the spreader pass a certain load level. If this problem occurs, it may be possible to limit the problem by varying the rate of dumping chips from the truck when the bed begins to reach the critical angle.



Rollers and Rolling

• Rollers are used in different rolling patterns depending upon an agency's approach to rolling for chip embedment. Some agencies use only one pass over the section, while some may specify five passes or even seven passes to complete the process. There is no clear evidence that "if a little rolling is good, a lot more rolling is better." However, it does appear that it is important that the last pass of the roller be in the direction of vehicle travel on that lane. The success of the chip seal is definitely related to the time between binder application and rolling. Several agencies require enough rollers for full coverage in a single pass. The success of the seal coat also seems to be related to the time that elapses from completing the rolling process until the section is opened to traffic. Once the chips have been embedded into the asphalt by rolling, to minimize the chips that are lost under traffic, it is important to allow enough time for the asphalt binder to begin to harden, especially in hot weather.

• Chips will be retained much better after the section has been rolled if the traffic allowed onto the freshly sealed section is required to operate at a reduced speed for at least one hour. Reduced speed can be maintained best by using a pilot car to convoy vehicles through the area. Posting reduced speed limits will be of some help if a pilot car operation is not feasible, but posting will not be as forceful. Keeping the speeds on the freshly sealed section in the range of 20 to 30 miles per hour is highly desirable.



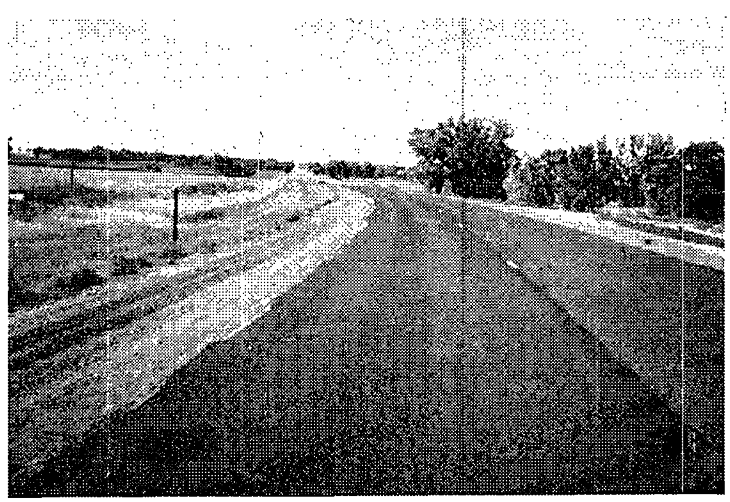
SLURRY SEAL—Engineering Factors

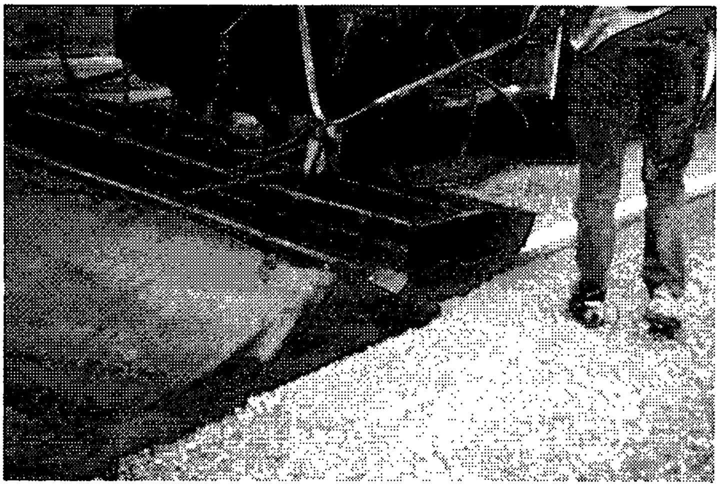
•Slurry seal mixture design is normally completed by the contractor. However, mixture design is critical and changes in aggregate sources or emulsified asphalt cement should not be allowed without a new mixture design.

• The success of a slurry seal depends a great deal upon the experience and skill level of the unit operators. Since the operators are critical in applying a good slurry seal, they should be allowed to change the amounts of water and slurry seal additives in the mix as they note changes in environmental conditions that, in the opinion of the experienced operators, suggest the need for immediate adjustment. The moisture content of the slurry seal aggregate may not be important to the operators if they can make changes to the mix as the appearance and texture of the mix change according to what is sensed by "eye and feel" in the operation. However, having a pre-set moisture content in the aggregate controls stability of the mix, consistency of the mix, and coating of the aggregate. For further information in evaluating these factors in your own slurry seals, see *Design Technical Bulletins - 1990*, International Slurry Seal Association.

• Oversized aggregate or large clumps of material tend to hang up on the strike-off bar. These large pieces of solid material tend to leave a streak or groove in the fresh slurry seal coat. During the curing process, these streaks will close up some, but there is a tendency for them to fill with water and they will generally reappear. A scalping screen should be used at the stockpile site to remove all oversize and clumped materials.

• Roads with superelevated curves make it difficult to control the slurry spreader box to provide for good flow of the slurry mix. Because the mix has a very fluid character, the mix tends to flow to the low side of the box rather than to be evenly distributed along the box. Slurry mix tends to flow out from under the low end of the box. When the low end is on the inside of the roadway curve, the slurry mix tends to flow out onto the shoulder. Keeping the edge of

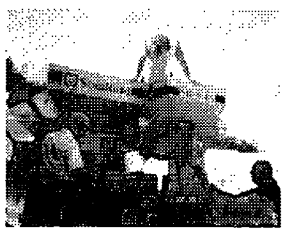


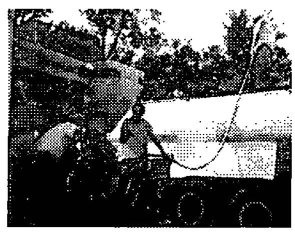


the spreader box on the edge of the paved lane will limit the spreading of the slurry mix onto the shoulder on super- elevated curves. Newer equipment with augers in the spreader box can minimize this problem.

Calibration and Construction

• Slurry seal contractors normally calibrate their equipment in the presence of an inspector before each job. However, some contractors may be in the habit of calibrating their equipment only once per year. Calibration procedures are readily available and are relatively simple.





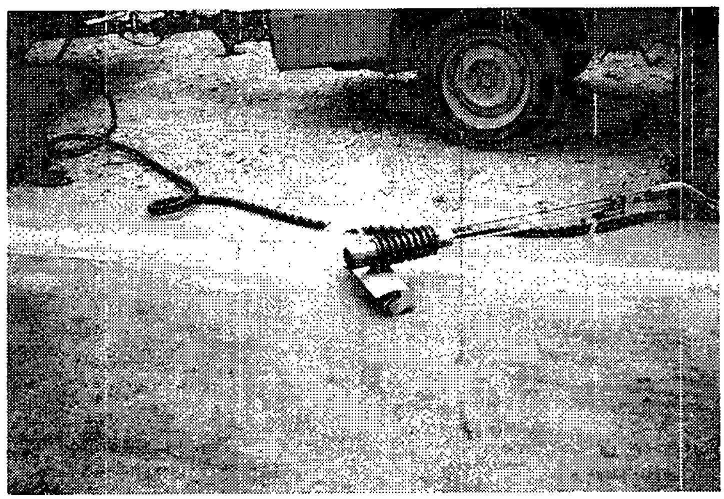
• Some equipment systems do not provide a gauge or meter to record how much water is added to the mix in making operator adjustments. It is helpful to be able to record the amount of water added. At some locations, adding excessive water to the mix may contribute to the slurry seal set time being much longer than expected. Specifications should require potable water be available to add to the mix, as water that is not potable is suspected to contribute to excessively long set times at several locations. Cement characteristics need to be specified for the mix and carefully monitored as variations in cement characteristics contribute to extremely fast set times at some locations.

• The necessary time from completing the placement of the slurry seal until the seal coated area may be opened to traffic is strongly influenced by the temperature of the pavement prior to placing the slurry seal. Specifications should include an upper and lower temperature limit for both air (below 70°F or above 110°F) and pavement (below 60°F or above 130°F). Temperatures below 60°F cause the slurry seal to set slowly, unnecessarily delaying the section from opening to traffic. High temperatures cause the slurry seal to set very rapidly, limiting workability and spreadability of the mix. Thus greatly increasing the water content may in turn adversely affect the long-term serviceability of the slurry seal. When the surface of a recently placed slurry seal approaches the temperature of adjacent untreated land, or a lane that had received a slurry seal much earlier, as measured by a noncontact thermometer, the recently sealed area is generally ready to be opened to traffic.

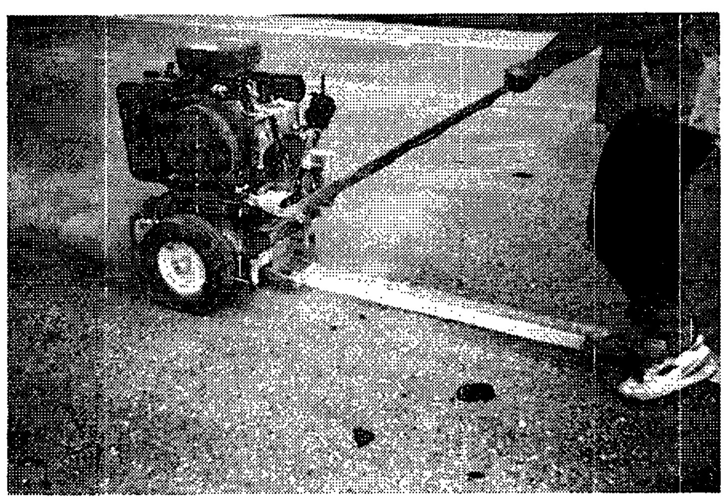
The shear strength of the slurry can be checked in a gross manner by placing your full weight on one heel and twisting it. If the heel twists over the mixture with only surface marks, the mixture can probably be opened to traffic without significant damage to the seal.

• Applying a slurry seal coat to a pavement surface that has deep ruts or depressions may result in the slurry seal acting somewhat like a leveling course. The increased thickness of slurry mix in the ruts or depressions will take longer to cure and should be observed before opening the section to traffic. Thus, slurry seal is not an appropriate alternative treatment for this kind of surface deterioration.

CRACK SEALING IN ASPHALT PAVEMENTS



• A hot-air lance was found to be an effective tool in obtaining high quality crack sealing. The lance is easy to operate and does not require extensive training to use properly. If a moderate amount of debris was left in the crack after it had been routed, two passes were required with the lance. The first pass was without heat to blow debris out of the crack and the second pass with heat was used to prepare the crack to receive the sealant. An alternative procedure is to rout all the cracks in the section, broom the surface with a power broom, blow debris out of the cracks with only compressed air, and then use the hot-air lance to prepare the crack for the sealant.

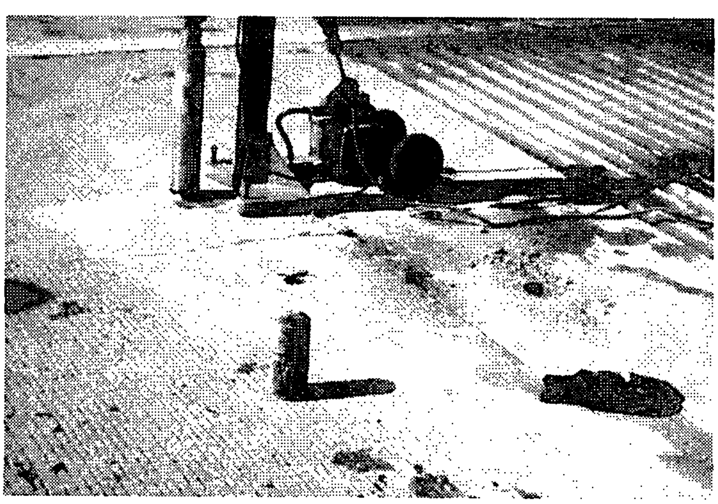


• Longitudinal cracks associated with paint striping and alligator cracking generally cannot be effectively treated by crack sealing.

• In one region the contractor rolled a layer of single-ply toilet paper over the freshly sealed cracks, up to one and one-half inches wide. The toilet paper kept debris from being blown or swept into the freshly sealed crack, decreased the time for the sealant material to form a skin at the surface, reduced the time until the section could be opened to traffic, and reduced the tracking of sealant material by vehicles driving through the freshly sealed cracks. Sand and other chippings can also be used with the added benefit of some increased skid resistance.

UNDERSEALING PORTLAND CEMENT CONCRETE PAVEMENTS

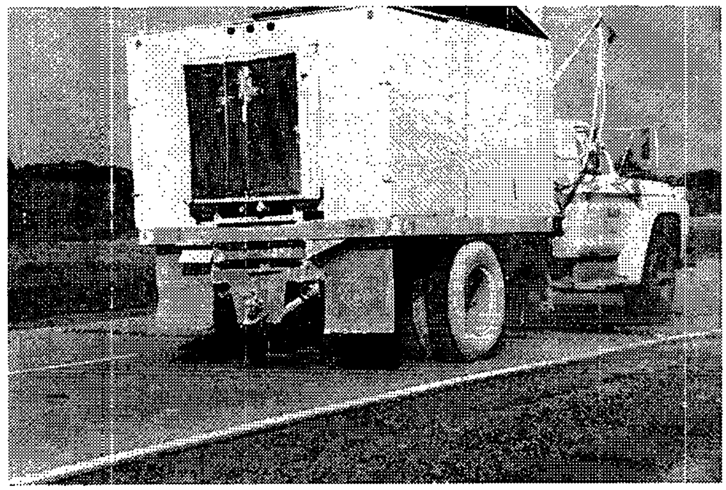
• Undersealing is used by some agencies in conjunction with joint sealing and other repairs in rigid pavements.



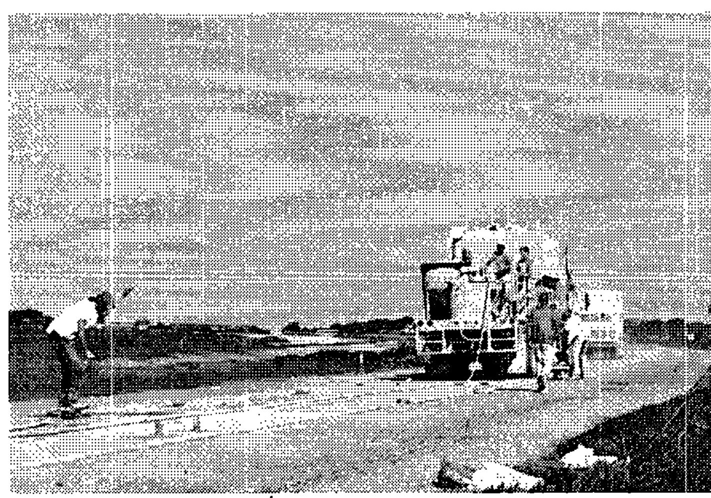
• Most state agencies or the contractors will measure deflection or some other attribute at each joint and crack to determine if a void is present. Undersealing should be completed only on those joints and cracks that are suspected of having voids. Deflections are often measured after the undersealing is completed to check the results.

• One of the major limitations to undersealing is having confidence in the estimated presence of and volume of voids under the pavement. A new test method, the "epoxy core test," was developed in this research. The epoxy core test proved to be an effective method to define the presence and thickness of voids. Although this test procedure is too time consuming and expensive to use for routine inspection, it can be used to verify the accuracy of less expensive testing procedures, it can also be used to verify that the contractors are filling voids but not lifting slabs. Basically, a small hole is drilled through the pavement in the vicinity of the suspected void near the pavement joint. Then a colored epoxy fluid is poured into the hole and allowed to set up, which takes a few minutes. Next, a small diameter core is drilled out containing the original epoxy core hole. A lens of material, including the base material immediately under the pavement, remains with the pavement core removed. This permits visual inspection and measurement of the thickness of any void layer that exists under pavement that the fluid epoxy has filled.

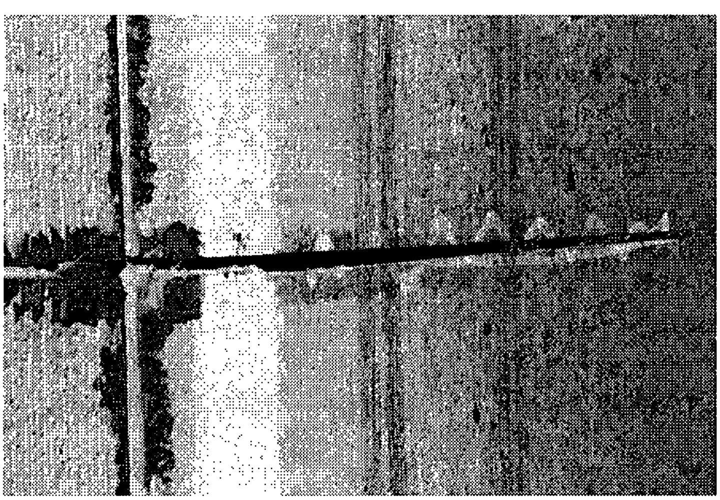
• Contractors who do extensive undersealing work have developed highly efficient equipment systems to drill the hole patterns adjacent to the joints through which the grout is injected. The hole drilling must be monitored as it is easy for holes to be drilled in joints beyond the intended distress area.



• During grout injecting, the flow of grout out of adjacent holes must be monitored. Injecting too much grout into the void can lead to pumping grout into edge drain systems or lifting of a slab, which will create new voids adjacent to those filled and lead to cracked slabs.



• The contractor should use a deflection measuring device while the grout is being pumped under the slab to ensure that the slab is not lifted by the grout.

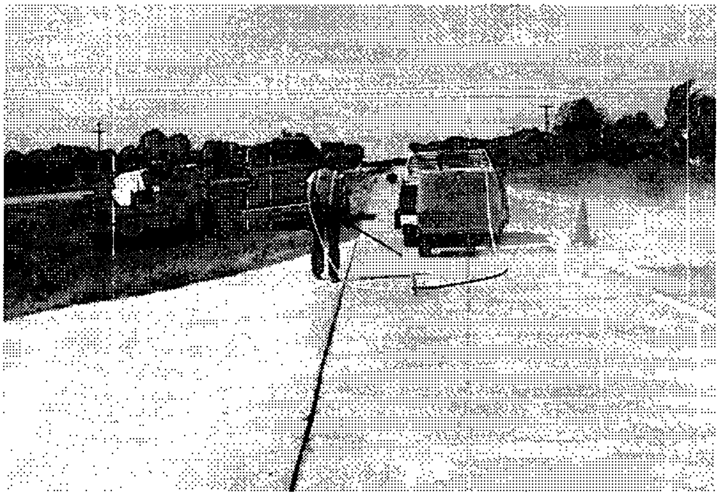


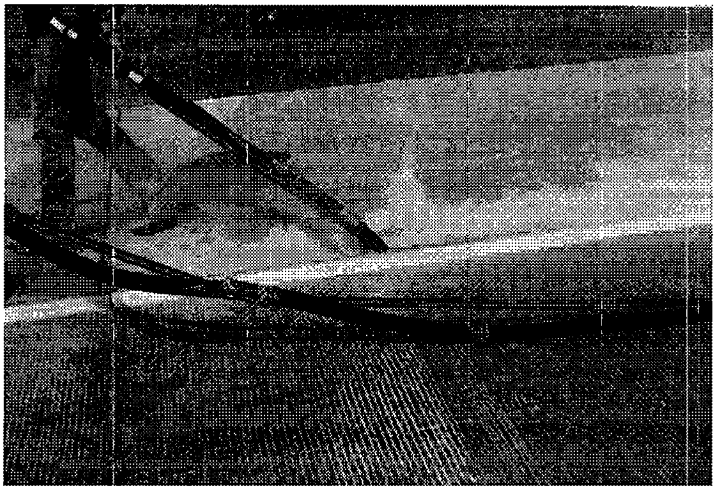
JOINT AND CRACK SEALING IN PORTLAND CEMENT CONCRETE PAVEMENTS

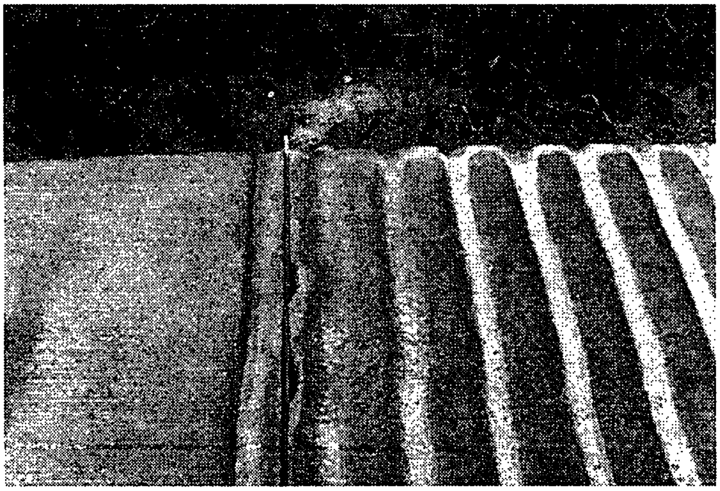
◦ Sawing the old sealant out of the joint or crack and providing a good, solid face seems easy and straightforward. However, it is important that saw operators have enough experience and skill to enable them to make the proper saw cut width and the proper saw cut depth. If the saw cut is not wide enough, some of the old sealant material may adhere to one side of the joint and cause the new sealant bond to break prematurely. If the operators allow the saw to drift off line from the joint, the cut will be ragged or jagged or too wide, requiring use of different sizes of backer rod to prevent sealant from dropping down past the backer rod.

• After the joint or crack has been sawed open to receive the backer rod, the saw cut must be cleaned. It is especially important when using silicone-based sealants that the saw cut faces be clean for a good bond between the sealant and the cut face. The saw cut faces should be cleaned by sand blasting to remove sawing residue and any remaining sealant residue, followed by compressed air alone to clean the saw cut of all sand blast debris. The reservoir should be checked by rubbing finger tips along the side of the reservoir. If any residue rubs off onto the finger tips, the joint or crack reservoir should be recleaned with sand blasting and air. It is important not to blow material from the roadway surface back into a clean saw cut.

• When the proper size of backer rod is installed in the saw cut it will be compressed slightly to hold the sealant material above it in the saw cut.







• When the joint has a spall or a saw cut that leaves an enlarged area, an extra backer rod or larger backer rod should be installed before applying sealant. If self-leveling sealant is used, a stiffer version of the same material should be placed over the backer rod with a caulking gun applicator to provide a seal over the backer rod. Otherwise the self-leveling material will flow around the backer rod and develop an improper joint seal.

• Applying the sealant to the proper depth in the saw cut will yield a smooth, clean joint to prevent infiltration of surface water and intrusion of incompressible sand and rock particles.

Continuing the Pavement Maintenance Effectiveness Effort

All maintenance personnel need to be aware of the importance of continuing to expand the maintenance database started under SHRP H-101. The following are factors suggested for all agencies.

Safeguard the initial H-101 test sections.

Test sections installed during the initial H-101 contract are a maintenance improvement resource extending beyond the initial five-year SHRP project. Share with all maintenance and construction personnel the critical need to retain the character of the sections to maintain the validity of data that will continue to be collected until the section requires replacement. Keep offices responsible for planning and design aware of the impact of their projects in the vicinity of test sections on those test sections themselves. It is especially easy to modify a control (no maintenance) section inadvertently, since we are not used to having a stretch of roadway that we intentionally let deteriorate. If we do not have valid control sections, however, we cannot tell how much of our pavement investment is retained by the maintenance treatments we are testing.

Report information on sections.

Keep collecting information on section maintenance information. Keep sending information on any safety maintenance required to the regional database manager for SHRP.

Contact the Long-Term Pavement Performance (LTPP) regional database office before any maintenance, rehabilitation, or reconstruction is completed beyond safety maintenance.

Regional LTPP personnel need to conduct a final field condition survey to close the research record on each test section. This may require some lead time if the regional office has a heavy data collection schedule. If maintenance personnel can anticipate the need to replace or repair a test section, the regional office can better coordinate the final field inspection.

Keep internal staff liaison informed.

State and local agencies participating in SHRP research have one or more persons who have been assigned to be liaison with the SHRP research program. Maintenance operations personnel need to keep these liaison persons aware of the status of all test sections. The liaison persons can help maintenance managers anticipate problems and opportunities in maximizing the total research effort, especially as the need for safety maintenance on test sections (including control sections) appears to be developing. The name, telephone and address of the persons in each agency assigned to act as liaison to SHRP should be disseminated widely throughout the agency. All personnel should be encouraged to contact the agency liaison on any matter regarding the test sections.

Share information.

Circulate research results in newsletters, conferences, workshops, news releases, and informal communications to improve operations. Encourage people to seek information. People trust what they understand.

Use the common data collection procedures developed for the LTPP portion of the SHRP study so that your research interfaces with the SHRP studies completed in your agency and in adjacent agencies. The LTPP data collection guide is available from the LTPP regional office.

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