Research Project 0-4061-P3

Comparison of Hot-Poured Crack Sealant to Emulsified Asphalt Crack Sealant

Field Manual for Crack Sealing in Asphalt Pavements

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January 2006

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Research Project 0-4061
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Product Number 3

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Acknowledgments

This project has been initiated and sponsored by the Texas Department of Transportation (TxDOT). The financial support of TxDOT is greatly appreciated. The authors would like to thank TxDOT Project Director John Bohuslav for his guidance. The assistance of the participating district maintenance personnel through the advisory committee, as well as other districts, is greatly appreciated.

Performing Organization: Center for Transportation Research, The University of Texas at Austin 3208 Red River, Suite 200 Austin, Texas 78705-2650	***Sponsoring Organization:*** Texas Department of Transportation, Research and Technology Implementation Office P.O. Box 5080 Austin, Texas 78763-5080	
Project conducted in cooperation with the the Federal Highway Administration and the Texas Department of Transportation.		
Keywords: Hot Poured Crack Sealants, Cold Poured Crack Sealants, Emulsified Crack Sealants, Asphalt Pavements		***No. of Pages:*** 16

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INTRODUCTION

This field manual was developed as a product of research project 4061 "Comparison of Hot Poured Crack Sealant to Emulsified Asphalt Crack Sealant" conducted by The University of Texas at Austin Center for Transportation Research (CTR). Organization of this field manual accompanies that of the "Crack Sealing in Asphalt Pavements" training video also developed by CTR.

Pavement cracking is an inevitable phenomenon that maintenance engineers have to accustom themselves to. It is impossible to construct a pavement that does not develop cracks after a certain amount of service time. Cracking is one of the two main concerns considered in the pavement design process (the other being rutting); it is the primary mode of deterioration in asphalt cement pavement. Cracking occurs in a variety of forms: transverse, longitudinal, block, and alligator shape. Cracks need to be treated promptly because they create openings for moisture to penetrate the pavement layers. Moisture or water can cause severe damage when trapped in the crack. Neglecting pavement cracking usually leads to accelerated deterioration of the pavement, resulting in significant problems such as potholes or base failures, which cause the serviceability of the pavement to decline.

Cracking, since it is such a major form of pavement deterioration, is usually the deciding factor in determining the proper time for rehabilitation and the appropriate method to be applied. When cracks develop on the surface of the pavement, it is a sign of reduction in pavement integrity and serviceability. Regular repair of pavement cracks is one of the main methods of preventive maintenance, since failure to repair cracks in a timely fashion can lead to accelerated deterioration of the pavement in the form of crack growth, spalls, secondary cracks, and potholes. The main causes of pavement cracks are thermal movements and fatigue due to excessive loading. Cracking is an inevitable problem given the network of more than two million miles of asphalt surfaced roads in the United States. It is important to find effective solutions to minimize its effect and to extend the service life of our roads.

TERMINOLOGY

Crack repair consists of crack sealing and crack filling. Usually, crack sealing refers to routing cracks and placing material on the routed channel. Crack filling, on the other hand, refers to the placement of material in/on an uncut crack. For the purposes of this manual, crack sealing will refer to both crack filling and sealing. Specifically, what is usually referred to as crack sealing will be referred to as crack sealing with routing.

PAVEMENT SELECTION

Preventative Maintenance

TxDOT employs crack sealing extensively as a cost effective technique in preventive maintenance. Preventive maintenance is characterized by its ability to preserve and extend the life of pavement. Since cracks on the pavement surface allow water and incompressible materials such as sand, dirt, and other debris to enter the pavement structure, the presence of these cracks can dramatically accelerate deterioration and weakening. Sealing cracks prevents further deterioration of the pavement and, when properly executed, can extend the life of the pavement anywhere from 6 months to 4 years. In many cases, when roads are selected for a full width seal coat (or chip seal) or hot mix asphalt concrete overlay, cracks that are 1/16 inch or greater in width will require crack sealing prior to the seal coat or overlay. If crack sealing is required prior to a seal coat or overlay, such crack sealing should be completed 6 to 12 months before the seal coat or overlay to minimize the potential for bleeding of the sealant thru the subsequent surface layer. Selecting the proper pavements for crack sealing is critical to ensure the preservation and extension of the life of the pavement.

Since crack sealing is a preventive

Figure 1. Fatigue Cracking

maintenance technique that adds no structural capacity to pavement, ideal pavement candidates for this technique exhibit minor pavement distress and have sufficient structural capacity to meet present and future structural needs. Pavements with transverse and longitudinal cracks are good candidates for crack sealing, but pavements with fatigue and alligator cracking, as displayed in Figure 1, should not be subjected to this maintenance technique. Fatigue and alligator cracking indicates pavement structure failure, and crack sealing will not extend the life cycle of this type of pavement condition. In addition to pavement selection, other considerations have to be taken into account for crack sealing, as discussed in the following section.

CONSIDERATIONS FOR CRACK SEALING

Time of Year and Temperature

Factors affecting crack sealing include the time of the year and the ambient temperature in which the treatment is applied. Crack sealing should generally be done during the winter months when the cracks are open; and thus, sealant can more easily penetrate the crack. The ambient temperature should be between 45 and 65 degrees Fahrenheit.

Safety

During the sealing procedure, the materials and the equipment involved can present safety hazards to both workers and the traveling public. All safety precautions regarding material handling and the operation of the equipment should be strictly adhered to. Additionally, construction workers should wear safety apparel such as long sleeved shirts, leather gloves, steel toed boots, hard hats, and adequate eye protection. Since hot pour crack sealants are applied at approximately 350 degrees Fahrenheit or more, special caution should be exercised during this operation.

Traffic Control

Perhaps the most important consideration for a crack sealing procedure is traffic control. In order to ensure the safety of all workers and the traffic traveling near the work area, proper traffic control devices should be installed. The Texas Manual of Uniform Traffic Control Devices (MUTCD)

Figure 2: Hot Air Lance

provides guidelines on traffic control devices for the TxDOT. The traffic control plan may need to consider the traffic volume and the curing time (or time between placement of sealant and removal of the traffic control devices) of the sealant selected for a work location.

Crack Cleaning and Drying

Before placing sealant, all cracks must be thoroughly cleaned to ensure a clean, dry crack channel and to optimize adhesion between the sealant and the pavement surface. Crack cleaning is an essential step in crack sealing since most failures occur as a result of loss of adhesion. To effectively clean the crack, high-pressure air blasting, which uses compressors to produce a jet stream of air, is used to remove dust, debris or loose pavement fragments. The cracks should be cleaned to a depth of at least twice the crack width. Airflow should be free of oil and moisture and the compressed air should have a minimum pressure of 100 lb/in^2 and minimum blast flow of 150 ft^3/min. These blasting operations should always be directed away from passing traffic. Although this method is very effective in cleaning the crack, it is not effective for drying it. For proper crack sealing the crack must be free of moisture. For drying, a hot air lance (Figure 2) can be used. Sealant should be placed immediately after crack cleaning.

If crack sealing with routing is the selected method, additional considerations must be taken into account. Crack routing involves cutting through the crack to provide a uniform rectangular reservoir in which the sealant is to be placed. This procedure creates uniform and smooth edges, thus allowing the sealant material to adhere better with the asphalt pavement.

Backer Rod

When sealing large cracks, it is important that the sealant does not drain to the bottom of the crack. To prevent this, sand or backer rods may be placed in the cracks before the placement of the sealant. As seen in Figure 3, using a backer rod when appro-

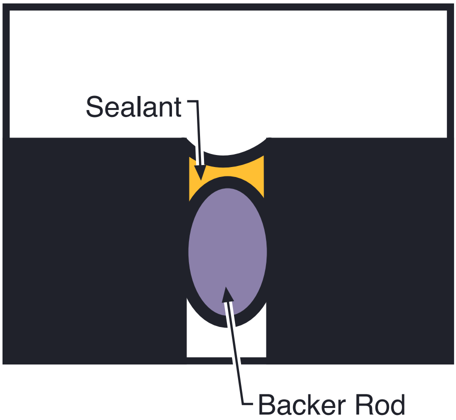

Figure 3. Backer Rod

Figure 4. Blotting

priate will prevent the sealant from draining to the bottom of the crack.

Blotting

When crack sealing wide areas, aggregate should be placed on the fresh sealant to maintain the skid resistance. All traffic must be kept off the sealant until it has cured. If traffic is inevitable before the sealant is cured, the seal can be blotted. Blotting is the application of fine aggregate or sand to the non-cured sealant to prevent tracking. The fine aggregate or sand must be applied immediately after the sealant material is placed so that it adheres to the sealant and can serve its purpose. Figure 4 shows the blotting process in progress.

METHOD SELECTION

To ensure an effective, long-lasting crack seal, the proper method must be selected. This selection will depend on the movement and physical characteristics of the crack. The main consideration in crack sealing method is the annual movement of the crack. Another important consideration used in method selection includes crack edge deterioration. Table 1 presents recom-

Table 1. Recommendations for Crack Sealing

Crack Characteristics	Crack Treatment Method	
	Crack Sealing w/Routing	Crack Sealing
Width (in.)	0.2 to 0.75	0.2 to 1.0
Edge Deterioration	Minimal to none ≤ 25% of crack length	Moderate to none ≤ 50% of crack length
Annual Horizontal Movement (in.)	≥ 0.1	< 0.1
Type of Crack	Transverse Thermal Transverse Reflective Longitudinal Reflective Longitudinal Cold-Joint	Longitudinal Reflective Longitudinal Cold-Joint Longitudinal Edge Distantly Spaced Block

mendations to follow when deciding between crack sealing and crack sealing with routing.

Crack Sealing

Appropriate candidates for crack sealing are non-working cracks—cracks that have horizontal or vertical movements less than 1/10 inch. These types of cracks are usually diagonal, longitudinal, or block cracks. Additionally, crack sealing should be considered for cracks that have moderate or no edge deterioration. These types of cracks do not require a routing process and the sealant is placed directly in the crack as seen in Figure 5.

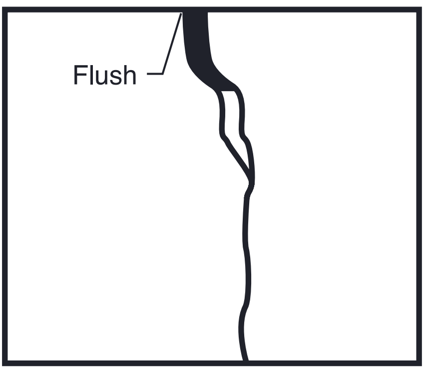

Figure 5. Crack Sealing

The most common configurations used with the crack sealing method are the flush fill and the overband, as shown in Figure 6.

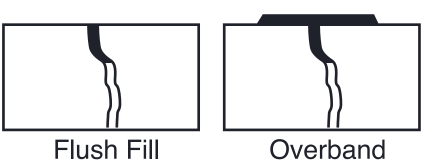

Figure 6. Crack Sealing Common Configurations

Crack Sealing with Routing

Working cracks, which are cracks that have horizontal or vertical movements greater than 1/10 inch, are recommended for routing. In general, this type of crack is transverse in orientation. Crack routing involves cutting along the crack to provide a uniform rectangular reservoir in which the sealant is to be placed. This procedure creates uniform and smooth edges, thus allowing the sealant material to adhere better with the asphalt pavement. Not only that, but crack routing also allows the sealant level to remain below the surface of the pavement. This protects the sealant material from traffic and snowplow contact.

If crack sealing with routing is the selected method, additional considerations must be taken into account. Special preparation should be done to the crack if there is limited crack edge deterioration. The preparation consists of routing the crack in order to place the sealant in the routed crack, or reservoir, as discussed earlier. In the crack sealing with routing procedure the most commonly used configurations are the reservoir and combination, as presented in Figure 7. Figure 8 displays the routing equipment used in the crack routing procedure.

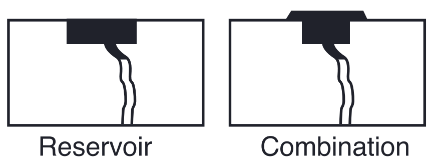

Figure 7. Crack Sealing with Routing Common Configurations

Material Placement

The material should be applied to the inside of the cracks. Excess sealant should be removed before hardening occurs. An overband should be formed during, or immediately after, sealant application. The overband should not be more than 3 inches wide and no more than 1/8 inch above the pavement surface. For hot-pour applications, the sealant should be poured at the manufacturer's recommended temperature. The sealant should be circulated in the hose when the installation train is idle. There should be no bubbles due to moisture present in the crack. For cold-pour applications, adequate sealant should be placed to seal up to the surface of the crack, since cold

Figure 8. Crack Routing Procedure

pour tends to flow deep into a crack.

MATERIAL SELECTION

Cracks should be carefully examined to determine the most suitable material for the project. The two commonly used materials for crack sealing procedures are cold pour and hot pour sealants. The test sections in TxDOT research study 4061 indicated that for crack sealing without routing cold pour has a typical life cycle of 1-2 years, while hot pour has a typical life cycle of 3-5 years. Specific procedures must be followed for each particular sealant material.

Cold Pour

Cold pour sealants are those that are applied at ambient temperatures and therefore do not require heating. This type of material is more appropriate for cracks of 3/16 inch or less in width. Emulsified asphalt is the most commonly used cold pour sealant. It is a dispersion of asphalt particles in water with the presence of an emulsifying agent that sets due to the evaporation of water when exposed to air. The main advantage of asphalt emulsions is safety, since it typically does not require heating. Additionally, they can be applied during times of high humidity or when cracks are moist or damp. However, such humid conditions result in a significant extension in the curing time.

Ideal conditions for cold pour sealant application are when the air temperature is above 40^{o}F and rising. Cold pour sealant should not be applied if the air temperature is below 50^{o}F and falling. This temperature should be based on a reading taken in the shade and away from any form of artificial heat. Due to the low viscosity of cold pour sealant, the material will penetrate into the crack easily without any need for routing procedures. It is critical that the vertical surface of the crack be clean to insure that the cold pour will adhere to the crack. The sealant should be applied using a barrel pump or pressurizing system to provide an uninterrupted flow of cold pour sealant

Figure 9. Rubber Finishing Squeegee for Use with Cold Pour Sealant

through the hose to the wand. The wand applicator should have an appropriate nozzle for applying the material in the crack. The squeegee, shown in Figure 9, should be kept over the center of the crack channel. Depending on the humidity and temperature, curing time can vary from 30 minutes to several hours

Hot Pour

Hot pour sealants are sealants that must be heated to high temperatures in preparation for application. As the material cools, the hot thermoplastics harden. This type of material generally consists of asphalt cement with or without the addition of a modifier. The simplest and most common type of modifier added to asphalt cement is rubber. Additions of such a modifier give the asphalt desirable properties such as high elasticity and high melting point. Unlike cold pour sealants, hot pour materials should not be applied when the cracks and pavement surface are moist and damp. All manufacturers' recommendations to determine an acceptable air temperature for application should be followed.

The hot pour sealant is heated in a double jacketed heater using heat transfer oil so that no direct flame comes in contact with the shell of the vessel containing the sealant. A picture of such machinery used for the heating of hot pour materials is presented in Figure 10.

To ensure that the sealant is circulated during the heating process to achieve a uniform rise in temperature and to maintain the desired temperature, the heated reservoir should be equipped with an agitator. Temperature should be monitored through accurate temperature gauges to avoid overheating the material. Ideally, the material should be maintained between 350 and 375^{o}F. The heater should be equipped with a gear driven asphalt pump with adequate pressure to dispense the sealant. The material is applied to the inside of the cracks as it is pumped through hoses connected to wands with adequate nozzles. For optimization of performance, the temperature of the material at the application nozzle should also be monitored. It should be maintained

Figure 10. Hot Pour Machine

Figure 11. Metal Finishing Squeegee for Use with Hot Pour Sealant

within manufacturers' guidelines.

The placement of hot pour sealant can begin after the application temperature is attained. If bubbling occurs, moisture still exists in the crack and work must be postponed until the cracks are dry. After application of the sealant material to the crack, a metal U-shaped squeegee should be used for finishing and shaping following the application wand. The metal squeegee is shown in Figure 11. The squeegee should be kept over the center of the crack channel and as close as possible to the applicator wand so that the sealant is fluid and workable.

It is critical that the squeegee work be completed immediately after the sealant is placed and before it cools. In most cases, the hot pour sealant will cure in about 15 to 30 minutes.

APPENDIX A

APPENDIX A:
QUALITY CONTROL CHECKLIST

Climatic Conditions

- Ambient temperature is at least 40^{O}F and rising.
- No fog or dew is present.
- Early morning operations should be performed in direct sunlight.

Routing

- Cutting tips are sufficiently sharp to minimize spalling and cracking.
- Proper safety garments are worn (hard hat, reflective vest, long-sleeved shirt, pants, steel toed boots, safety goggles, and hearing protection).
- Guards and safety mechanisms on equipment work properly.
- Router follows cracks without difficulty.
- Routs on asphalt concrete pavement are free of spalling.

Material Preparation

- Proper safety garments are worn (hard hat, reflective vest, long-sleeved shirt, pants, steel toed boots, safety goggles, and hearing protection).
- Melter is empty and no material is reheated.
- Heating oil in melter jacket is not fuming and level is adequate.
- Temperature gauge on the melter has been calibrated within the last 6 months.
- If the temperature gauge has not been calibrated:
  a) Measure sealant temperature with a hand held thermometer every 30 minutes.
  b) Ensure that the reading on the hand held thermometer is the same as the reading on the melter temperature gauge.
- Sealant is never reheated above the manufacturer's recommended pouring temperature.
- Material safety data sheet (MSDS) is available on-site.

Cleaning of Cracks and Routs

- Proper safety garments are worn (hard hat, reflective vest, long-sleeved shirt, pants, steel toed boots, safety goggles, and hearing protection).
- A power sweeper or vacuum cleaner is being used to remove dirt and debris from the pavement surface.
- Compressor for high-pressure air provides at least 100 lb/in2 of pressure.
- Oil and moisture filters on compressor work properly.
- Temperature of the hot-air lance is below 930^{O}F and the tip is 2 to 4 inches from the crack or rout (if applicable).

- The cleanliness of the crack or rout is being checked every 30 minutes.
- The crack or rout is dry.

Sealant Application

- Hot-pour sealant is poured at the manufacturer's recommended temperature.
- Sealant recirculates in the hose when installation train is idle.
- The material is applied to the inside of the cracks.
- For cold pour sealants, check to insure that adequate cold pour sealant is placed to seal up to the surface of the crack, since cold pour tends to flow deep into a crack.
- There is sufficient sealant to allow for a 1/5 to 2/5 inch band or bridge on either side of the crack (if applicable).
- There are no bubbles due to moisture present.

Overbanding of Sealant (if applicable)

- Overband is not more than 3 inches wide.
- Overband is not more than 1/8 inch above the pavement surface.
- Overband is formed during, or immediately after, sealant application.
- Excess sealant is removed before hardening.

Sealant Protection

- Hot-poured sealant surface is covered with fine aggregate or sand at intersection
- Traffic is rerouted until sealant is set.

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