# Equipment for Improving Pavement Crack Cleaning Operations

*Requested by*
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## Table of Contents

# Executive Summary

## Background

The Caltrans Division of Maintenance continually seeks improved methods and equipment to increase efficiency and worker safety, which in turn supports Caltrans' mission and goals. The sealing of highway pavement cracks and longitudinal joints has been identified as an area possibly in need of enhancement. Unsealed pavement cracks, either in the form of random stress failure cracking or linear joints, accelerate highway pavement deterioration due to water and debris penetrating the structural section, thereby undermining pavement integrity. According to Federal Highway Administration (FHWA) study results [1], a properly installed, heated application of rubberized asphalt joint seal should remain effective an average of five years. All the major sealant manufacturers recommend the crack or joint be dry and free of all dirt, dust, debris, and vegetation prior to applying their rubberized asphalt sealants for optimum performance. Failure to properly clean a pavement crack or joint may result in the seal failing as soon as one thermal cycle, i.e. in less than one year. Unfortunately, conventional highway pavement crack cleaning techniques are innately labor-intensive and require workers to be on foot and exposed to traffic for prolonged periods of time, which often downgrades crack preparation tasks to low priority in a sealing operation. Caltrans Maintenance is interested in a broad look at equipment used by other state transportation agencies, as well as any recent innovations in crack cleaning technologies that may be utilized by Caltrans Maintenance to enhance highway sealing operations and thereby improve pavement maintainability statewide. Additionally, equipment that could be paired with the Sealzall machine (discussed below) is of special interest due the potential to create a high-efficiency crack cleaning and sealing operation that removes workers from traffic exposure.

This Preliminary Investigation (PI) sought to investigate all conventional crack cleaning techniques and equipment effective at cleaning, drying, and removing incompressible materials and vegetation from random cracking and longitudinal joints on highway pavements. The identified technologies will be classified in this report as contact, non-contact, and cutting. Contact methods include wire wheels and sweeper brooms. Examples of non-contact methods include compressed air blasting and heat lances. Cutting methods include the impact router, diamond saw, rotary hammer, and vertical spindle router. Frequently, a cutting process is followed by one or more contact or non-contact methods to clear debris from the reservoir prior to sealing. The table in Figure 1 includes the approximate manpower requirements and production rates for common crack treatment operations when utilizing standard equipment [2].

| Operation | Equipment | Manpower | | Approximate Productivity, ft/min[a] |
|---|---|---|---|---|
| | | Equipment | Driver | |
| Crack Cutting | Routing (vertical-spindle router) | 1 | — | 1.5 to 2.5 |
| | Routing (rotary-impact router) | 1 | — | 12 to 15 |
| | Sawing (diamond-blade crack saw) | 1 to 2 | — | 4 to 7 |
| Crack Cleaning and Drying | Airblasting (blowers) | 1 | — | 12 to 18 |
| | Airblasting (compressed air) | 1 | 1 | 10 to 15 |
| | Hot airblasting (hot compressed-air lance) | 1 | 1 | 5 to 10 |
| | Sandblasting (sandblaster) | 2 to 3 | 1 | 3 to 4 (2 passes) |
| | Wirebrushing (wirebrush) | 1 | — | 9 to 12 |
| Material Installation | Drums and pour-pots | 2 to 3 | 1 | 5 to 10 |
| | Asphalt distributor with wand and hose | 2 | 1 | 15 to 25 |
| | Melter-applicator | 2 | 1 | 15 to 25 |
| | Backer rod | 2 | — | 9 to 15 |
| | Silicone pump and applicator | 2 | 1 | 6 to 12 |

**Figure 1. Typical Manpower Requirements and Production Rates for Crack Treatment Operations.**

Caltrans makes a sizeable investment in resources every time crews are sent out on the highway to seal pavement cracks and joints. Therefore, it is essential that the seal be applied in a manner conducive to meeting or exceeding the anticipated five-year seal life on the highway. Ensuring that the pavement cracks or joints are dry and free of all dirt, dust, debris, and vegetation is critical to achieve this goal. Ideally, the application of the cleaning method should produce a demonstrable increase in joint seal longevity, offsetting the additional cost of any cleaning operation. For older, debris-filled, deteriorated joints, the cleaning process should thoroughly prepare the joint for sealing. For newer joints, the quality of the seal must be improved either by enhancing pavement surface adhesion or by generating a longer-lasting type of seal in order to be worthwhile. The goal of this PI is to develop a comprehensive perspective of state-of-the-art crack cleaning methods and equipment to assist Caltrans' identification and implementation of the most beneficial tools to enhance their highway crack sealing operations. This study further includes a literature review of the current practices of other State Departments of Transportation (DOTs) regarding the application of pavement crack cleaning techniques.

## Summary of Findings

All of the conventional crack cleaning technologies currently in use on the highway are low-tech, manual labor methods that require minimal operator training and have changed little in the past couple of decades. The only significant equipment maintenance issue for conventional crack cleaning technologies is the time required to change the consumable carbide star blades on impact routers. Otherwise, standard equipment maintenance and serviceability schedules are followed for crack cleaning equipment.

### Non-contact Cleaning Technologies

Effective surface preparation can sometimes be accomplished with one of the non-contact methods, such as compressed air blasting. The non-contact methods can be applied manually or, in the case of longitudinal joints, be easily adapted and attached to vehicles and operated from within the vehicles. Non-contact technologies do not change the physical state of the crack but simply remove loose, incompressible debris and potentially light vegetation from the void. They may also warm the pavement around the crack area.

#### Compressed Air Blast Cleaning Techniques

Compressed air blasting is the most common crack cleaning preparation technique employed by Caltrans Maintenance crews for all types of crack and joint sealing operations statewide. A compressed air blast directly into a pavement crack dislodges and clears loose debris from the void and potentially cleans the crack walls, promoting sealant adhesion (Figure 2). Virtually all DOTs sealing pavement cracks utilize some form of compressed air blasting in their crack cleaning and sealing operations either alone or in conjunction with other cleaning methods. Caltrans Maintenance crews typically rent a towable skid-mounted 125 CFM air compressor, to which they attach a hose and handheld blowpipe to facilitate crack cleaning.

#### Heat Blast Cleaning Techniques

Heat blasting generally involves injecting super-heated air directly into a crack or joint in the pavement surface. The air stream can be either low-pressure, typically generated by a blower fan, or high-pressure, typically generated by a two-stage rotary screw air compressor. The airflow is ideally heated to approximately 2,000º F for efficient drying performance and vegetation burning. The general purpose of the heated low-pressure blower fan is to heat and dry the pavement surface and the crack walls just prior to sealant application, thereby promoting adhesion and prolonging seal longevity. The high-pressure heated blast, commonly referred to as a "heat lance," has the added benefit of blasting loose debris from the crack as it heats the pavement. Propane burners are the most efficient source of heat for heat lances; flameless burners and electrical heating element models are available. An example of a flameless burner heat lance is shown in Figure 3. While the high-temperature air is favored to burn out the vegetation growing in the crack, it poses a risk of igniting roadside fires and should therefore only be used in appropriate conditions. Heat lances utilizing flameless burners or electrical heating elements can be throttled down to a lower operating temperature, reducing the wildfire risk, but the drop in their effectiveness is significant. DOTs that utilize heat lances extensively in their sealing operations and specify their use in contract jobs are typically located in wet regions where wet pavements are commonplace. A heat lance's principal value is drying pavements in preparation for sealing, which is an issue that Caltrans Maintenance can generally manage through the seasonal timing of crack cleaning.

**Heat Lance Equipment**

- http://www.forconstructionpros.com/company/10073616/lab-manufacturing

**Figure 2. Compressed Air Blast Crack Cleaning**

**Figure 3. LA*B Flameless Heat Lance**

Surface Blower Equipment

Surface blowers are sometimes utilized to remove surface dust and debris from the crack surface in preparation for the application of sealant. These walk-behind, self-contained, engine-driven units can be configured as air-blowing or vacuum units depending on the specific DOT crack cleaning priorities.

**Pavement Blower**

- http://www.littlewonder.com/asphalt-paving-2/

Crack-Vac™ System

The Crafco Crack-Vac™ system (Figure 4) combines a compressed air blast with a high-power vacuum to loosen, remove, and collect dust and debris from pavement cracks. The truck- or trailer-mounted, self-contained system contains a 35-foot suction hose, which is manually guided along the crack to be cleaned. The Crack-Vac filter system captures particulate matter down to ten microns. This new concept in crack sealing preparation limits worker exposure to dust and improves visibility problems that dust can cause for nearby motor traffic.

**Crack-Vac™**

- http://www.crafco.com/equipment/debris-removal-and-crack-preparation

Herbicide Spraying

Caltrans will sometimes spray herbicide on vegetation growing in highway pavement cracks as a crack preparation method weeks prior to either conducting additional cleaning methods or applying sealant. Killing the vegetation helps any follow-up cleaning methods more easily remove the vegetation. Also, applying hot sealant to a crack filled with living vegetation only kills some of the vegetation. A significant amount of the heartiest weeds will survive and begin growing through the seal. Spraying the vegetation prior to sealing greatly reduces the chance that the weeds will survive and grow through the seal, especially in cases where no additional cleaning is performed after the spraying. Vegetation in cracks on the highway is most prevalent outside the traffic lanes.


**Figure 4. Crafco Crack-Vac™**

## Contact Cleaning Technologies

Contact crack cleaning methods do not alter the pavement crack in any meaningful way but do prepare the pavement surface for sealing in the immediate vicinity of the crack. Contact surface cleaning operations do not effectively remove debris from the void, so crack sealing is essentially a surface overband configuration, referring to the sealant adhering predominantly to the road surface, rather than the inside walls of the crack. Contact methods essentially provide a clean, fresh pavement surface to which the sealant overband can adhere.

### Wire Wheel Cleaning Techniques

Engine-driven, portable, wire wheel surface preparation machines are popular with DOTs and contractors. Caltrans Maintenance crews often utilize these wire wheel devices in their crack sealing operations. Conventional wire wheel cleaning devices require manual operation, with workers on foot on the pavement to guide the wire brush along the crack. Cleaning pavements with wire wheel devices primary results in a clean surface around the crack or joint, which can promote the adhesion of an overband of sealant. Wire wheel cleaning also does a fair job of removing vegetation growing out of pavement cracks. Wire wheel cleaning often is combined with compressed air blasting to deep clean the crack of light debris and to clean and remove vegetation from the crack's surface.

**Wire Wheel Surface Preparation**

- http://www.billygoat.com/Product-Categories/Detail/grazor-gz401h

**Wire Wheels**

- http://www.contractorsdirect.com/574233201-Husqvarna-Wire-joint-Brush

### Sweeper Broom Cleaning Methods

Sweeper broom vehicles are commonly used by all DOTs to efficiently remove dust and debris from the pavement surface in the work area. Broom brushes are not effective for deep cleaning a crack or joint and are often used in conjunction with deeper cleaning operations. Broom brushes sometimes run just ahead of sealant application operations to provide a minimal level of surface preparation and to promote sealant adhesion.

## Pavement Cutting Technologies

Results from the Strategic Highway Research Program (SHRP) H-106 study showed approximately a 40% greater chance of successfully sealing cracks if they are routed prior to sealing [1]. The cutting of a reservoir above the crack allows adequate sealant expansion and contraction to take place at lower seal tensile stresses. The reservoir also ensures the proper amount of sealant penetrates into the crack and, more importantly, greatly increases seal adhesion. The recessed reservoir also protects the seal from traffic wear, which is especially important across traffic transitions. A blast of compressed air (hot or cold) typically follows the cutting head to remove the dust created during the pavement cutting process. All of the current commercially available contact and crack cutting cleaning equipment requires a worker to be on foot during the operation.

Pavement cutting methods consistently provide the most controllable and uniform joint crack cleaning result. Pavement cutters will remove even the most packed incompressible debris and deeply rooted vegetation from longitudinal transition joints. Pavement cutting technologies represent both the most efficient and the most expensive means of crack cleaning and preparation used by DOTs.

Vertical Spindle Routing Operations

Vertical spindle routers consist of an engine-driven, vertically spinning carbine pin cutter mounted on a maneuverable wheeled cart. The cutters range from ¼-1 inch in diameter and have a cutting depth up to 1¼ inches deep. The operator grasps the handlebar to guide the cutter along a crack, which provides the operator a direct line of sight to the cutter. The contact point the vertical cutter makes with the surface allows the vertical router to trace even the most jagged pavement cracks. Vertical routing creates an adequate sealing reservoir along the crack, promoting sealant adhesion to the crack walls and extending seal longevity. Vertical spindle routers are not often utilized as highway pavement crack cleaning devices by DOTs due to their comparatively slow production rates and the relatively short wear life of the vertical pavement cutters.

**Vertical spindle router**

- http://www.salsco.com/products/paving-and-curbing-equipment/pavement-router.html

Diamond Saw Cutting Operations

Diamond sawing, or diamond chasing blade cutting, is generally the best method of cutting and cleaning cracks and joints exclusively in Portland Concrete Cement (PCC) pavements. Diamond saws are manual, self-contained devices that require an on-foot worker to guide the cutter precisely along the crack or joint to be cleaned. Because Asphalt Concrete (AC) pavements tend to stick to the diamond blade, thereby generating excess heat and potentially ruining the expensive blades, diamond saws are not utilized on AC/PCC transition joints. Longitudinal joints are typically AC/PCC, but sometimes PCC/PCC longitudinal joints are encountered on the highway. Typically, PCC/PCC joints are found on highway concrete structures, but concrete shoulders are slowly becoming more prevalent on newer highways.

**Diamond Saw Router**

- http://cimlinepmg.com/crackpavementsaw.html

**EZ Rider Joint Cutter**

- http://www.mathis-kelley.com/pd105641/diamond-products-cc7800-

Impact Routing Techniques

The impact router is the most commonly used device when cutting AC pavements to create a sealant reservoir. DOTs in the northern regions of the country utilize impact routers extensively when crack sealing on AC pavements to mitigate the greater thermal cycling of working pavements in these more extreme climate zones. A standard impact router utilizes carbide-tipped star cutters mounted free-spinning radially around a cutting drum driven by a gasoline engine (Figure 5). These self-contained routing devices are steered by a worker on foot along a pavement AC crack or joint, typically cutting a ¾-inch wide by ¾-inch deep sealant reservoir. The equipment is relatively heavy, making it strenuous work, and it also may produce a dust cloud that obscures workers' visibility. The impact router shown in Figure 6 has an optional dust collection system to reduce the negative effects of creating a dust cloud. Together with the cost of the expendable cutters and the awkward cutter change process, impact routing is a fairly expensive operation.

**Figure 5. Impact Router Cutter Head**


**Figure 6. Dust-Contained Impact Router Cleaning a Random AC Joint**

Routing a longitudinal transition joint is an easier task than routing a random in-lane crack since the PCC edge is relatively straight. Steering the router is less difficult and, in most cases, a guide wheel can be added to make the cutting head self-track along the longitudinal crack

(Figure 7). This enables the router to travel at the maximum cutting speed of up to 2 mph when removing mostly debris and vegetation, based on testing. An image of the test guidance disc trials on a standard configuration impact router is shown in Figure 8. At cutting speeds much above 2 mph, the impact router cutter tended to rise out of the crack and walk across the pavement surface.

**Figure 7. Impact Router Longitudinal Guide Disk**

**Figure 8. Impact Router Cleaning a Longitudinal Joint**

**Common Impact Router:**

http://cimlinepmg.com/router.html

**Skid Loader Mounted Impact Router:**

http://www.autoflagger.com/RapidRouter.html

Rotary Hammers

Caltrans District 11 has utilized rotary chipping hammers to follow cracks with a cleaning tool, also referred to as chasing cracks, in broken PCC pavement slabs to prepare for epoxy sealing. In the following images, Caltrans maintenance forces on foot use Hilti-type chipping hammers to create a reservoir for PCC slab cracks on I-8 in El Cajon. These first-stage or third-stage PCC pavement slabs cracks were then sealed with either Fastpatch or Concrete Weld. After more than four years, they are still in good shape.

**Figure 9. Rotary Hammer PCC Crack Preparation**

## Research Devices

Vehicle-Mounted Cleaning Attachment Testing

The only record or report pertaining to vehicle-mounted cleaning attachments found during this PI involved the Sealzall research and development program [3]. These hydraulically-powered attachments mounted to the Sealzall platform were tested by Caltrans on State Route 4 in a moving lane closure operation (Sealzall machine described later). The attachments consisted of a wire wheel version (Figure 10) and a carbide-tipped circular saw version (Figure 11). These attachments accomplished the task of removing debris and vegetation from the longitudinal transition joint but took four times as long to prepare the joint as the Sealzall took to seal it.

**Figure 10. Sealzall Wire Wheel Attachment**

**Figure 11. Sealzall Carbide-Tipped Circular Saw Attachment**

Crack Cleaning Device (CCD)

A new device under development for cleaning cracks and joints on pavements combines a heat lance, wire brush, and vacuum into a single implement (Figure 12). The CCD is being developed at the University of Nebraska-Lincoln and may be marketed by Crafco Mfg. in the near future [4].

**Figure 12. Crack Cleaning Device (CCD)**

## Gaps in Findings

There were no gaps in the findings.

## Next Steps

Caltrans' Seal Service Life Target

The primary focus of this PI study is highway pavement crack preparation and cleaning techniques for Caltrans Maintenance's possible implementation. In order to consider a broader perspective on sealing operations, Caltrans Maintenance might first consider the importance of seal configurations shown in Figure 13. The sealant configuration is the driving factor in seal life cycles, and dictates the methods, equipment, and operational procedures required by the DOT to achieve the configuration. For example, the results of the SHRP H-106 field test study of hot-applied asphalt sealant demonstrated that the standard recessed overband (Configuration B in Figure 13) achieves a service life of approximately 90 months [1]. The simple overband configuration achieves approximately a 45-month service life (Configuration D in Figure 13), and the commonly used air blast and capped seal configuration has an approximately 18-month service life (Configuration H in Figure 13). The application of crack preparation techniques is generally driven by the desired seal configuration. Caltrans Maintenance's interests might be best served by researching the cost/benefit of configuration based on seal life, costs (labor, equipment, materials), and other factors in order to optimize seal performance on the highway.

Potential procedure to improve highway sealing effectiveness

1. Determine the required seal service life necessary to justify conducting a sealing operation on a site-by-site basis or by specific policies.
2. This minimum seal service life requirement will drive the required seal configuration.
3. Based on the seal configuration and the condition of the crack to be sealed on the highway, determine the necessary supplemental cleaning methods.
4. With the intended seal method established, a list of ancillary issues will be taken into account. Some common issues Caltrans Maintenance faces on a regular basis with highway maintenance operations include: limited highway access due to traffic, weather conditions, manpower, supplies, and access to the necessary equipment. Any of these issues may prompt the modification of a crack sealing operation.
5. Track seal performance over the expected service life of the applied highway sealing operations to verify cost effectiveness and optimize crack cleaning methods.

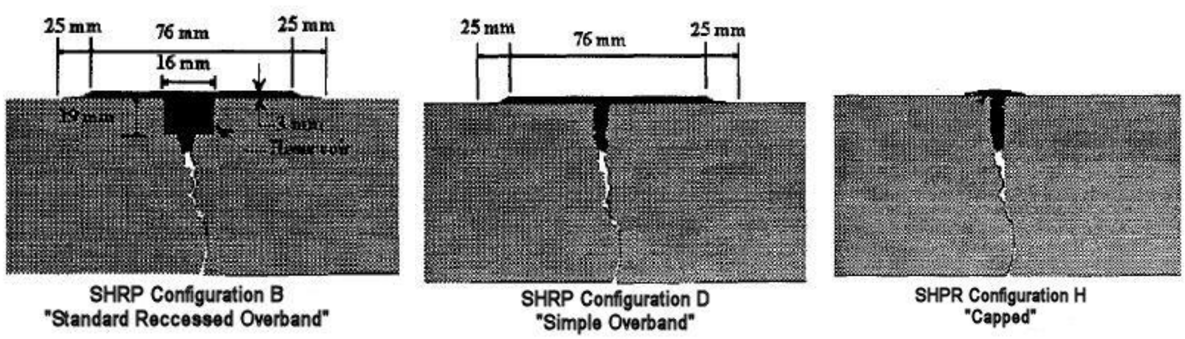


**Figure 13. SHRP H-106 Seal Configurations [1]**

Crack Cleaning Implementation Project

Caltrans could consider developing a Caltrans-specific crack cleaning implementation plan. This would include a detailed study recommending which crack cleaning techniques are cost-effective for Caltrans Maintenance to deploy. The study would adapt crack cleaning methods for Caltrans applications and evaluate their benefits based on highway field trial data.

- Identify, adapt, or develop cost-effective crack cleaning strategies and equipment for the Caltrans-specific highway operations and produce the specific seal configurations.

- Assist with the limited implementation of the identified crack cleaning equipment appropriate to Caltrans Maintenance highway sealing operations.
- Study and document Caltrans Maintenance trial sites for the various cleaning methods and quantify potential benefits.
- The study should generate a detailed cost/benefit analysis of the implementation of crack cleaning methods in Caltrans highway pavement crack sealing operations.

<u>Sealzall Crack Cleaning Strategies</u>

The Sealzall (Figure 14) is a fully self-contained vehicle designed to dispense rubberized hot-applied sealants from an on-board 400 gallon, oil-jacketed kettle. When configured for longitudinal crack sealing, the Sealzall machine is ideally suited to seal the transition joints between PCC slabs and AC shoulders. The clip-on longitudinal sealing head has an integrated squeegee that produces a desirable uniform and smooth seal appearance. The Sealzall can seal longitudinal cracks at a continuous speed up to 5 mph, which is more than double the speed of the conventional manual sealing operation. Moving lane closure longitudinal crack sealing is a key factor in the dramatic production rate increase that Caltrans has experienced when utilizing the Sealzall machine. Automation of the sealant kettle and sealant application systems provides the driver with full control of the complete sealing operation from inside the truck cab. Utilizing the Sealzall enables smaller Caltrans crews to effectively seal an expanded range of highway cracks which would otherwise be unrealistic to access and seal with conventional manual operations.

**Figure 14. Caltrans District 11 Sealzall Sealing Interstate 15**

In light of the success of the Sealzall prototype, Caltrans stakeholders may be interested in maximizing the efficiency of Sealzall sealing operation on various highways. Many different strategies and methods may be instituted to enhance Sealzall operations. The following list presents strategies for Caltrans to consider, all of which would assist in extending the Sealzall's application to AC/PCC longitudinal joint sealing operations statewide.

a) Develop a minimalistic crack cleaning vehicle which could feature a powered wire brush wheel to remove surface vegetation and air blast to loosen debris from the longitudinal joint. The vehicle might also include a vacuum system to collect dust and debris, which would be quite beneficial in the moving lane closure operation. The basic configuration would be a dual-steer truck with a commercial construction vacuum system mounted on the truck bed and towing an air compressor. A hydraulic-driven wire wheel brush and air blowpipe would be mounted to front bumper, extendable two feet out from either side of the front wheel axle. The combination of the cleaning machine and the Sealzall operation would enable Caltrans to seal longitudinal joints that range from one to four years old using a moving lane closure.

b) If Caltrans stakeholders have the goal to deploy a joint cleaning machine to enable the Sealzall to effectively seal all longitudinal joints regardless of age or the degree to which debris and vegetation is packed into the joints, then pavement cutting would be the most efficient approach. The development of a crack cutting machine that complements the Sealzall would be a large-scale machine development project, and the first step in the process would be a preliminary design study. With the details and options of the design as a starting point, Caltrans stakeholders could decide on the final design and the best way to proceed toward the fabrication of the desired equipment.

c) Should Caltrans stakeholders be interested in the concept of hot rolling a groove in new or partial-width shoulders, a preliminary study and presentation should be prepared that describes the proposed process, costs, and equipment needed.

# Detailed Findings

## Related Research and Resources

### Caltrans Flexible Pavements Materials Program

**Chapter 3: Crack Sealing, Crack Filling & Joint Sealing of Flexible & Rigid Pavements**
Caltrans Maintenance Technical Advisory Guide, October 2003.

http://www.dot.ca.gov/hq/maint/mtag/ch3_crack_sealing.pdf

### Maintenance Technical Advisory Guide (MTAG) Volume 1 Flexible Pavement Preservation, 2nd Edition

**Chapter 1 - Introduction**
Caltrans Division of Maintenance, February 2008.

http://www.dot.ca.gov/hq/maint/FPMTAGChapter1-Introduction.pdf

### Long-Term Pavement Performance (LTPP) Pavement Maintenance Materials:

**SHRP Crack Treatment Experiment, Final Report (SHRP H-106)**
K. L. Smith and A. R. Romine, ERES Consultants, Inc.
Federal Highway Administration, FHWA-RD-143, September 1999

http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=133

### Research Results Digest 339

**Improving the Safety of Mobile Lane Closures**
A. Hadayeghi and B. Malone, Synectics Transportation Consultants, Inc.
National Cooperative Highway Research Program
N. Srinivasan, Senior Project Officer, August 2009

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_339.pdf

## Consultation with State DOTs

A survey was conducted of other state DOTs to determine what methods they use to clean cracks prior to sealing and their general experiences. Of the fifty state DOTs contacted, eight responded to the questionnaire.

This brief survey of current practices was sent by the Caltrans Division of Research, Innovation and System Information (DRISI) to the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) for distribution.

1. Does your agency clean cracks or joints before applying hot applied sealants? If so, please briefly describe the current methods of crack cleaning your agency utilizes.
2. Are any of your current crack cleaning operations suitable (or appear suitable) for moving lane closure operations? If so, please provide details on the operations and equipment that are suitable (or appear suitable) for moving lane closure operations.
3. Please share any other suggestions, information, or research you may have pertaining to moving lane closure crack cleaning equipment or technologies.
4. If you feel your agency has more information to offer on this subject, please provide contact information to allow a follow-up discussion.
5. Please provide any other information or feedback that you believe may be of value for this research.

The following agencies and persons responded to the survey:

## Arizona Department of Transportation

Responder: Bruce A. Fenske, P.E., Senior Operations Engineer
Southwest District, Arizona Department of Transportation, BFenske@azdot.gov

1. The Southwest District of the Arizona Department of Transportation cleans cracks before applying hot-applied sealants. Crack sealing is a mobile operation whereby an individual walks behind a truck. S/he uses a wand to spray hot-applied sealant and fill the larger cracks. The person who cleans the cracks walks in front of the truck while using a blower, such as a gasoline-powered leaf blower, to blow out dust, dirt, and debris so that every crack is clean when filled a few minutes later.
2. Safety is the number one priority of the Southwest District of the Arizona Department of Transportation. Lane closures typically include use of a truck-mounted attenuator (TMA). A moving closure needs to protect the workers in front of the TMA and provide sufficient time for sealant to cure before opening the lane to the public. Cure time is usually not an issue because crack sealing occurs during the winter months when cracks are at their widest and ambient air temperatures are 80 degrees Fahrenheit or below.
3. None.
4. If you need a copy of a typical traffic control plan or specifications on crack sealing, please

contact - Bruce A. Fenske, P.E., Senior Operations Engineer.

5. None.

## Illinois Department of Transportation

Responder: Ryan R. Culton, P.E., Research Implementation Engineer
Illinois Department of Transportation, Bureau of Research, Office of Planning & Programming, Ryan.R.Culton@illinois.gov

1. Yes, the cracks and joints are blown clean with an air lance connected to an air compressor. The compressor shall have a minimum of 90 psi.
2. There are a lot of issues that need addressed, but they could be suitable for moving lane closures.
3. To our knowledge - the Illinois Department of Transportation has not attempted an automated crack cleaning operation.
4. No response.
5. There are automated pothole filling machines that use compressed air to clean the pothole before applying cold patch.

## Indiana Department of Transportation

Responder: Clinton Bryant P.E., Operations Field Engineer
Indiana Department of Transportation, cbryant@indot.IN.gov

1. Yes. INDOT's practice is to use compressed air to clean out cracks prior to using hot applied sealant. A hot air lance may be used if the pavement isn't fully dried but our preferred practice is to wait until the pavement is fully dry before applying sealant. Cracks should be free of debris and moisture to a depth of at least twice the width of the crack.
2. Yes (depending on the situation). Normally on a multi-lane road, the operation will be an intermittent mobile operation. Normally on a two-lane road, the operation will require the use of flagmen but may still be a mobile operation. TMAs (truck-mounted attenuators) are the only additional equipment used in a mobile operation as opposed to a stationary work zone.
3. None.

4. None.
5. If you have any additional questions or need information (such as INDOT's Maintenance Performance Standards, work zone setups or research on crack maintenance not tied to mobile operations), please contact Clint Bryant (cbryant@indot.IN.gov) at (317) 914-9124.

## Iowa Department of Transportation

Responder: Brian Worrel, P.E., SPR Research Engineer
Office of Research & Analytics, Iowa Department of Transportation, Brian.Worrel@dot.Iowa.gov

1. Most crack filling done by maintenance forces is in a closed lane setting with flagger or pilot cars in operation to control traffic. If routing is required this is most likely done through contract letting system and once again either closed lane (multi-lane roads) or pilot cars to control traffic flow.
2. The only operation the maintenance forces use a moving operation set-up on would be crack sealing type of work.
3. In the past, I remember seeing a system that said they could rout and seal from inside the cab with a moving operation. The Iowa DOT did not continue that research at the time the unit was cost prohibitive.
4. Not at this time.
5. No response.

Upon follow-up with Iowa DOT to obtain additional information on the question 3 response, Kenneth Morrow with Iowa DOT replied as follows...

> This was a commercial driven project, not sure that I could find the information this many years later, if a Google search or other researches have not found anything like this in operation today. In the mid to late 1990s IDOT was still doing a large amount of crack sealing and some rout and seal work with our own forces, it was in this time frame I remember this unit being discussed. I will try and see if our person that deals with IDOT equipment recalls anything on this and has any of the old information.

## Minnesota Department of Transportation

Responder: Steve M. Lund, P.E., Director, Office of Maintenance
Minnesota Department of Transportation, steven.lund@state.mn.us

1. Yes, we use a 185 cfm portable air compressor to blow the cracks out. The employees are outside the vehicle.
2. We haven't been using the mobile lane closures for crack sealing. It would be possible if the frequency of cracks were low.
3. None
4. No response.
5. No response.

## Nebraska Department of Transportation

Responder: Tom Renninger, Assistant Operations Division Manager/Maintenance Manager
Nebraska Department of Roads, tom.renninger@nebraska.gov

1. Yes, we do by simply a person walking behind the air compressor blowing the crack out or by using a heat lance method.
2. NDOR doesn't use a "moving lane closure" for this activity all work is done a "closed lane"
3. No response.
4. No response.
5. No response.

## South Carolina Department of Transportation

Responder: David Cook, State Maintenance Engineer
South Carolina Department of Transportation, CookDB@scdot.org

1. Cracks in asphalt pavements and concrete pavements are typically cleaned and dried prior to installation of sealant by the use of a hot lance and compressed air. Additionally, concrete pavement joints are typically routed as well.
2. No.
3. None.

4. N/A

5. N/A

## **Washington State Department of Transportation**

Responder: Lu Saechao, PE, Research Manager

Washington State Department of Transportation, SaechaL@wsdot.wa.gov

1. Yes we clean cracks, Standard Specifications Section 5-04.3(4)A Crack Sealing as amended is as follows:

    1) 5-04.3(4)A Crack Sealing
    2) 5-04.3(4)A1 General
    3) When the Proposal includes a pay item for crack sealing, seal all cracks ¼ inch in width and greater.
    4) Cleaning: Ensure that cracks are thoroughly clean, dry and free of all loose and foreign material when filling with crack sealant material. Use a hot compressed air lance to dry and warm the pavement surfaces within the crack immediately prior to filling a crack with the sealant material. Do not overheat pavement. Do not use direct flame dryers. Routing cracks is not required.
    5) Sand Slurry: For cracks that are to be filled with sand slurry, thoroughly mix the components and pour the mixture into the cracks until full. Add additional CSS-1 emulsified asphalt to the sand slurry as needed for workability to ensure the mixture will completely fill the crack. Strike off the sand slurry flush with the existing pavement surface and allow the mixture to cure. Top off cracks that were not completely filled with additional sand slurry. Do not place the HMA overlay until the slurry has fully cured.
    6) Hot Poured Sealant: For cracks that are to be filled with hot poured sealant, apply the material in accordance with these requirements and the manufacturer's recommendations. Furnish a Type 1 Working Drawing of the manufacturer's recommendations to the Engineer prior to the start of work, including the manufacturer’s recommended heating time and temperatures, allowable storage time and temperatures after initial heating, allowable reheating criteria, and application temperature range. Confine hot poured sealant material within the crack. Clean any overflow of sealant from the pavement surface. If, in the opinion of the Engineer, the

Contractor’s method of sealing the cracks with hot poured sealant results in an excessive amount of material on the pavement surface, stop and correct the operation to eliminate the excess material.

7) 5-04.3(4)A2 Crack Sealing Areas Prior to Paving
8) In areas where HMA will be placed, use sand slurry to fill the cracks.
9) 5-04.3(4)A3 Crack Sealing Areas Not to be Paved
10) In areas where HMA will not be placed, fill the cracks as follows:

    Cracks ¼ inch to 1 inch in width - fill with hot poured sealant.

    Cracks greater than 1 inch in width – fill with sand slurry.

2. Traffic control for crack sealing is not a moving closure.
3. No response.
4. No response.
5. No response.

# Contacts

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