the GUIDE to CRACKSEALING

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Cracksealing is one form of preventative pavement maintenance that ensures the consistent operation of our nation's roadways. Contractors and municipalities extend the life of our highways and parking lots and save taxpayer money with cost-effective cracksealing materials and devices. For ideal sealant performance, crews must be educated on the proper use of cracksealing equipment and accessories, the proper sealant application, and the importance of job site safety.

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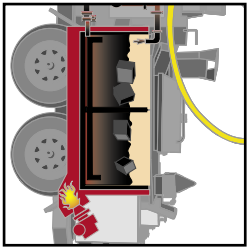


WHY CRACKSEAL?

Cracksealing lengthens the life of our nation's streets, highways, parking lots and patios made of asphalt or concrete.

Pavement cracks develop due to expansion and contraction caused by temperature fluctuation. These cracks allow water to penetrate the pavement base and sub-base materials, causing pavement elements to lose structural integrity. If not repaired or prevented this cracking effect will grow, leading to deformation of the pavement, pot holes, and ultimately the degradation of asphalt and concrete surfaces.

Cracksealing is preventive maintenance against water from further damaging roads. The use of hot and cold-applied sealants minimizes water penetration, sub-surface ice formation and traffic erosion. Most importantly, cracksealing lengthens the life of roadways, parking lots and patios made of asphalt or concrete. According to several of the country's DOTs, with timely preventive cracksealing the useful life of highway pavements can be extended up to 10 years in comparison to other temporary surface treatments such as chip seals, micro paving, thin overlays and slurry seals. As an added benefit, cracksealing is executed at one-sixth the cost of conventional pavement rehabilitation or reconstruction.

Keep in mind, cracksealing is preventative maintenance, not reconstruction. When a roadway or parking lot is "alligatored" or has incurred more extensive damage than a few cracks, the area must be cut out and replaced or patched.

Low loading heights and loading doors positioned above the fenders of the model supply correct ergonomics, preventing repeated stress and lifting injuries. A properly designed angled loading door, when closed quickly, prevents splashing of hot sealant.

Especially on busy, highly congested roads, traffic and workzone safety is extremely important. First, traffic movement should be inhibited as little as is practical. The use of traffic control devices to guide motorists through approaching construction should be implemented. The use of arrow boards, strobe lights, cones and a shadow vehicle are highly recommended. Throughout the project, the safe storage of equipment and materials in the work zone is necessary.

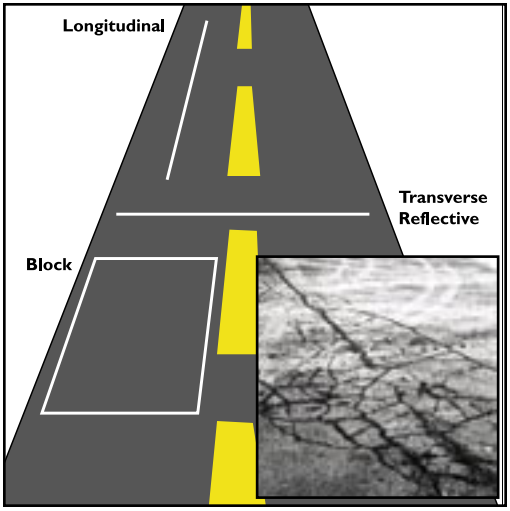
When operating cracksealing equipment and accessories, crews must be conscious of their safety. Flying debris, hot sealant, and heavy equipment operation require focus. Eye protection is a must, and full-face shields are sometimes necessary. Long pants, long-sleeved shirts, and gloves that fit tight all the way up onto the forearm prevent injury from hot equipment and sealant. Hard hats also provide protection.

Cracksealing equipment and accessories are engineered with safety features that promote operator comfort and prevent accidents on the job site. For example, some melter/applicators feature fume reduction systems, which draw the majority of asphalt fumes by convection back into the burner exhaust. This mixture is dissipated more thoroughly through the exhaust stack, reducing harmful air pollution. Several models also feature noise reduction systems.

Recent melter/applicator models also ensure operator safety and comfort through low overall height and stability systems that meet transportation safety guidelines. Saws, routers and other cracksealing tools have automatic kill switches and brake systems to prevent injury.

Crews should always avoid the use of alcohol and drugs when on the job.

TYPES OF CRACKS



Pavement cracks appear in several different shapes.
***Inset:* An alligatored pavement should not be cracksealed. This type of deterioration requires removal and repair.**

Transverse/Reflective Cracks:

Cross either from shoulder to shoulder or from shoulder to centerline. Caused by inability to redistribute stresses that occur along pavements' width and length as temperature increases.

Longitudinal Cracks:

Run the length of the pavement, roughly parallel to centerline. Caused by inability to redistribute stresses that occur along pavement's width and length as temperature increases.

Block Cracks:

Block or square pattern, spaced between 4 and 12 feet. Caused by traffic load and volume or by failures in base or subgrade materials.

Alligator/Map Cracks:

Pattern that resembles alligator skin or road map. Caused by serious deterioration of road; cannot be saved by cracksealing.

Parking Lot Cracks:

Block-type, random fashion 10 to 20 feet apart. Caused by pavement aging, oxidizing or shrinking. (Sometimes caused by sub-base failure; this issue should be addressed from the sub-base up.)

Routers are typically used to widen and deepen existing random cracks in Asphalt Concrete Pavement (ACP).

Preparation of pavement cracks is important in successful sealant application. Routing or sawing random cracks prior to installation provides clean surfaces for sealant application and a 40 percent greater chance of sealant success. Cutting the pavement along the crack lines provides a reservoir for sealant in smaller cracks and an intact sidewall for adhesion.

Some industry professionals skip this step and move on to the cleaning process, a method known as "blow and go." However, routing and sawing cracks before sealant installation is recommended, and will eventually become a job specification requirement. Cracks will need to be prepared with a router or saw before installation, creating a smoother, deeper reservoir for sealant installation. A clean or concave surface will be required in anticipation of the installation of the new SuperPave system (See Sealant Application). Without routing or sawing before sealing, the new technology's performance could be compromised.

Routing

Routers are typically used to widen and deepen existing random cracks in Asphalt Concrete Pavement (ACP). Routers are equipped with a rotating drum with bits. These bits can be configured for wide or narrow cuts on the job site and allow for maneuverability in mid-cut and adjust with a screw feed to the necessary depths.

Crack saws are most commonly used in Portland Cement Concrete Pavement (PCCP) for pavement maintenance before sealant installation, and in new concrete construction.

Because flexible pavement highways endure more movement, they require different routing depths depending on crack spacing. Generally, cracks should be cut to a depth half the length of the width. Some sources recommend different cutting depths depending upon crack spacing and the kind of traffic the pavement endures. When spacing exceeds 40", pavement cracks experience more stress and should be cut to 1.25" wide by 1" deep. Parking lot pavement moves less than highway pavement, and typically requires cutting .75" to 1" wide by .75" deep. As a rule of thumb, a routed crack should never be more than 1" deep. When routing is completed, the widened cracks should have a square cut with no rough edges. Routing should not be executed on cracks that have been previously sealed.

Sawing

Crack chasing saws use diamond blades that produce clean, straight lines and are used for crack chasing or slab sawing in Portland Cement Concrete Pavement (PCCP). Crack chasing requires 5" to 8" diamond blades to allow for maneuverability and accuracy. Cracks should be cut 1/2" to 1" deep for sealant installation. Sawing is also used in new concrete construction as prevention against cracking. Saw cuts should be 2" to 3" in depth. Saws typically do not widen cracks beyond 1/4" to 3/8".

Back blowers are popular tools for crack cleaning. High-pressure air removes dust, gravel and other contaminants.

Contamination in a pavement crack can cause poor sealant bonding. Dirt, dust and remnants from routing and sawing need to be removed to provide a clean surface. Armed with effective crack cleaning equipment, some professionals skip the routing or sawing step of crack preparation and move directly into cleaning, known as "blow and go." However, skipping the routing/sawing step in crack preparation is not recommended.

Crack cleaning equipment is designed to remove everything from small particles to gravel and sand with powerful air pressure and suction methods. Compressed air can be used to loosen and remove dirt easily. Some professionals prefer the use of back blowers to clean cracks. Most municipalities prefer the high-pressure air from a standard, full-size air compressor for crack cleaning and other general use. A vacuum sweeper also removes fine dust, while larger particles can be removed with a broom or mechanical sweeper at the end of the cleaning process. Sweeper bristles vary depending on the manufacturer, but large capacity mechanical broom sweepers with poly-wire mixtures are the most durable and reliable.

HEATLANCING

A hot air lance, or heat lance, combines super heated air with compressed air to clean the crack sides, remove moisture and heat crack sides to create a better surface for sealant adhesion.

The chances of good sealant bonding are reduced by several factors including cold temperatures, dirt and moisture. To create a clean, dry surface, The Strategic Highway Research Program (SHRP) recommends that cracks be treated with a heat lance, or hot air lance, before sealant installation. Hot air lances are designed to mix propane and compressed air to produce hot air. Depending on the manufacturer, heat lances output flame or flame-free heat. These accessories generate upwards of 2,000° F to remove moisture and provide additional cleaning to the cracks. Heat lances normally require more cubic feet per minute from air compressors than standard blowers. Check your equipment specs. In most cases, a heat lance is mounted to the truck, pulling the kettle. The placement on the front of the truck allows operators to heat the crack immediately before it is sealed. Operator attention is required at this step in the process; the crack should be thoroughly heated, but not burned.

This particular hot melt crack and joint sealant block is the equivalent of 3 gallons of melted sealant. The block weighs approximately 30 pounds, equaling 10 pounds per gallon.

Understanding the components and performance requirements of a sealant is extremely important. If the wrong type of sealant is used, the economic benefits of cracksealing versus other forms of maintenance or restoration are no longer applicable. The appropriate sealant varies with each job, depending on issues such as climate and vehicle and pedestrian traffic. In any case, there are basic properties that are necessary for acceptable performance:

1) Easily and properly placed in crack through standard application equipment.

2) Adhesion to remain bonded to asphalt and concrete crack faces.

3) Resistance to softening and flow at high pavement temperature.

4) Flexibility and extensibility to remain bonded to crack faces when extended at low temperatures.

5) Elasticity to restrict the entrance of foreign, noncompressible materials.

6) Resistance to degradation from weather.

7) Low cure time.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The sealant should come from an approved source or one listed on the Qualified Products List (QPL), a state-provided resource that sets the standard for safe, quality products for pavement maintenance. According to tests conducted by the American Society of Testing and Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO) and federal agencies, the best performing sealant is a polymer-modified sealant that relaxes during full extension, placing less stress on the bond of the sealant. Sealants should always be field tested before installation. Operators must ensure that the sealant packaging is not damaged. There are three major categories of crack/joint filling materials.

1) Hot-applied thermoplastic materials, a.k.a. Hot melt crack and joint sealant

The primary components of these sealants are asphalt cement, polymer, reclaimed rubber and mineral filler. They are for use on Asphalt Concrete Pavements (ACP) or Portland Cement Concrete Pavements (PCCP). These sealants come in two different varieties. Direct fire sealants are designed to perform in direct fire kettles, where heat is imposed directly onto the sealant. Oil-jacketed varieties are designed to melt under the influence of kettles that use heat transfer oil as a medium, where there's less chance for burning and scorching. Contractors and municipalities should be aware of the type of melter available to them. Hot-pour sealant can be a good investment on any size project. How much sealant to purchase can be calculated with a hot pour crack sealant coverage calculator once a contractor or municipality receives job specs. Sealant blocks, or biscuits, weigh approximately 30 pounds and are individually wrapped in polyethylene bags.

Crack/Joint Specs

Width (In.)	Length (Ft.)	Depth (In.)	Sealant Required
1 1/2	100	1/4	**19 lbs. 1 block**
1 1/4	120	3/8	**28 lbs. 1 block**
1	150	1/2	**39 lbs. 2 blocks**
7/8	170	5/8	**48 lbs. 2 blocks**
3/4	200	3/4	**58 lbs. 2 blocks**
5/8	240	7/8	**65 lbs. 3 blocks**
1/2	300	1	**75 lbs. 3 blocks**
3/8	400	1 1/4	**94 lbs. 4 blocks**
1/4	600	1 1/2	**111 lbs. 4 blocks**

2) Cold-applied thermoplastic materials

These types of sealants are rubberized asphalt emulsions with mineral fillers, used for narrow cracks up to 3/4 inch in width in ACP or PCCP pavements. These sealants cannot be used when rain is in the forecast or when temperature is or will drop below 50° F. Cold pour crack sealants usually require stirring and can be applied with a pour pot or pressurized crack-filler equipment, followed by a squeegee (See Sealant Application). Cold-applied sealants are economically sound for smaller jobs, but do not provide economic benefits on high-volume projects. These sealants are typically packaged in gallon-measurement pails, drums, or stick form.

3) Silicone Crack Sealant

These types of sealants can be used for sealing expansion saw cuts. Silicone sealants are applied using bulk or tube dispensers and are typically packaged in drum, pail or tube form.

The Table is a general reference for purchasing hot pour crack sealant in 30-pound blocks to accommodate particular crack widths, lengths and depths. One 30-pound block is equivalent to 3 gallons. Check the sealant's product data sheet for specific information. Contractors and municipalities should always know the job specs before purchasing the sealant. It is recommended that the purchaser account for field waste and purchase 10 to 15 percent more than the required quantity.

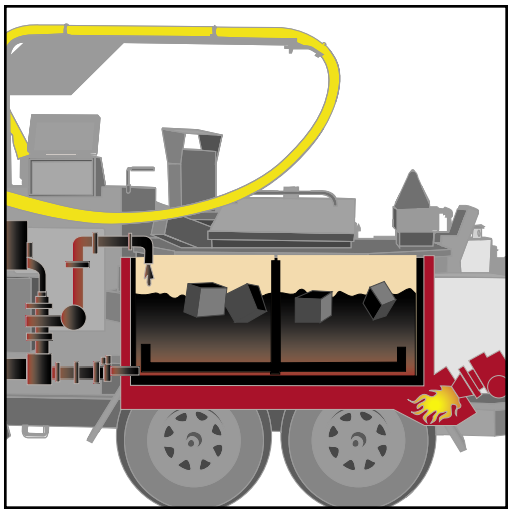
Some sealants are designed to perform in a direct-fire melter. These models feature direct heat without the use of heat transfer oil, and are for low volume applications.

Most contractors and municipalities prefer to use hot sealant in place of cold pour sealant because cold sealants in general have a high shrinkage property. Sometimes heated sealant is necessary for a particular job because the air temperature is too cold or the crack is larger than can be maintained with a cold pour sealant (see Choosing a Sealant).

Equipment

Sealant melters are known as double-jacketed, oil-jacketed, or double boilers. Generally these machines use heat transfer oil as a medium to heat the melting chamber which heats the sealant. This system eliminates burning and keeps the melting chamber at a consistent, ideal temperature between 350° and 410° F. Some melters have a recirculation feature that draws hotter sealant from the bottom of the tank and circulates it back to the top to mix with cooler material. Recirculating material this way speeds the melting and heating process and prevents temperature stratification. This feature is particularly important when using fiberized sealant or a sealant with mineral filler, when constant mixing and agitation is necessary to ensure that components are distributed and the sealant will perform.

HEATING THE SEALANT



Some melters work by recirculating sealant from the bottom back to the top, ensuring consistent sealant temperatures.

Melters are typically skid or trailer mounted and melter/applicators are equipped with a material delivery or pumping system. This system includes single or double hoses with wand attachments that are used to apply the heated sealant directly into the cracks. Hose and wand application take the place of witches hats or pour pots (See Sealant Application). Direct-fire kettles also provide fast sealant melting for smaller volume projects. These models do not employ the heat-transfer oil and require specific types of sealant.

Depending on the size of the project and the capacity of the kettle, feeding the melting chamber may require more than one person. Larger-volume projects may require two workers to feed one or both sides of the kettle. Well-designed melter/applicators feature one or more loading doors depending upon melter capacity and job requirements. Angled loading doors provide for easy opening, and along with a quick closing motion, prevent splashing of hot sealant. Loading heights as low as 47 inches minimize operator fatigue.

Ideal Temperatures

Manufacturers instructions will advise you on how hot the sealant should be upon application. Typically, the recommended application temperature will range between 350° F and 410° F. An infrared heat gun is an excellent instrument to assure ideal sealant placement temperatures and assure quality control.

As it cools, sealant shrinks in volume 14 percent.

One of the most important aspects of sealant application is timing. In severe hot or cold temperatures, pavement components react and sealant performance is not ideal. Air temperatures between 45° and 65° F put the cracks in the middle of their working ranges, so spring and fall provide the best temperature range for crack sealing. Knowledge of application methods and the machinery involved are important elements for an effective seal.

Techniques and equipment vary at this stage in the crack sealing process, and application is dependant upon the type of sealant and the machinery available to the contractor or municipality.

Hot Pour Sealant

Tools

Once the sealant is heated, (See Heating the Sealant) some professionals use a cone-shaped pour pot or witches hat to receive the material. The pot is carried over the cracks with the bottom valve open during installation.

When using a melter/applicator, heated sealant can be applied through a delivery hose and wand. Some models are available with non-heated or heated hose options for higher production.

Working with heated materials requires operator concentration and proper attire (see Safety).

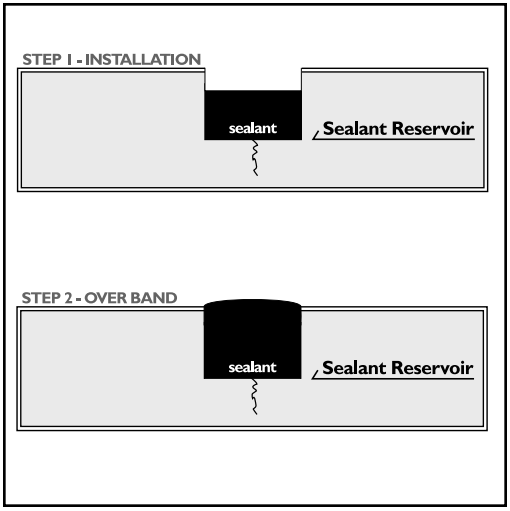
Sealant should never set higher than 1/8" above the pavement level. V-shaped squeegees allow crews to flatten the sealant over the crack and remove excess. This is a particularly important step when cracksealing pavement that will eventually be overlayed with SuperPave.

Method

Contractors and municipalities have their own methodology for sealant application. The crack should be filled about three quarters of the way, then allowed to cool. During this process, the sealant will shrink in volume 14%. After the cooling period, the crack should be completely filled. Some professionals suggest the overbanding technique, where the sealant is allowed to band over the crack, approximately a 1-2" out onto the pavement on each side. These techniques ensure that the crack is more efficiently sealed from infiltration of moisture.

The sealant should never set higher than 1/8" above the pavement level, where it can be picked up by snowplows and other pavement cleaning equipment. To prevent a convex form from setting, a U- or V-shaped squeegee or a sealing shoe can be applied to flatten the sealant over the crack and remove excess sealant. The squeegee creates a sort of concave seal, allowing for contraction and expansion of the pavement during extreme temperature conditions.

Eventually, concave application techniques will become a requirement due to the acceptance of the Superior Performing Asphalt Pavements' System (SuperPave) in the United States. The SuperPave system is comprised of a patented large-aggregate mix design, conformed into thin layers. Because of the larger aggregate components and thin body of the pavement, overbanded cracks can contribute to compaction and segregation issues on SuperPaved roads, and therefore is not recommended.



Step 1: **Installation**
Fill the crack 3/4 with sealant. Allow to set.
Step 2: **Overbanding**
Fill the rest of the crack, allowing some sealant to overband. Use a squeegee to flatten excess sealant.

Cold pour sealant application

In general, cold pour sealants must be mixed well before using, and can be applied as is. Popular techniques vary. Operators can use a pour pot, a caulking gun, or apply the sealant with a putty knife directly from the pail. Pressurized spray application equipment can also be used. These machines are capable of spraying pavement sealant with sand added, and provide continuous agitation and mixing to maintain a homogenous consistency. Fill cracks completely, then scrape away excess using a U- or V-shaped squeegee, or a putty knife. The surface can be sealed only after the filler has cured. Silica sand is sometimes used to promote adhesion to pavements, particularly in hot climate conditions.

Some cracksealing work is blotted with tissue paper, applied with a rolling tool.

In ideal situations, traffic should be kept off the newly crack-sealed surface until the sealant has had time to cure or "tack." This will minimize any tracking and allow for maximum adhesion to the surface. To allow traffic onto the surface sooner, blotting the crack is acceptable. There are three general methods for proper blotting:

1) Several forms of liquid chemicals are available that can be sprayed over the newly installed sealant to speed the tacking process.

2) Limestone dust can be applied to the new cracksealed joint.

3) Tissue paper is applied directly onto the fresh sealant with a special tool and allowed to disintegrate. Once the crack is blotted, traffic can resume within minutes.

FINAL CLEANING

Small portable self-propelled brooms are perfect tools for final cleaning of cracksealed surfaces.

Most pavement maintenance or restoration jobs require further steps, such as sealcoating, overlays or striping. These projects require a clean surface. Once the sealant has set, a broom or sweeper is necessary to remove fine dust, gravel, dirt, clay and other debris from the working surface. Powered sweepers can normally complete the job.

RESOURCE

For further materials and resources, the following organizations and government departments provide literature and access to archived research projects.

1) U.S. Department of Transportation
   www.dot.gov
2) Federal Highway Administration
   www.fhwa.dot.gov
3) Strategic Highway Research program
   www.wsdot.wa.gov/fossc/ota/shrp
4) Long Term Pavement Performance program
   www.tfhrc.gov/pavement/ltpp/ltpp.htm
5) Foundation for Pavement Preservation
   www.fp2.org
6) Cimline Incorporated
   www.cimline.com

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For more information on Cracksealing Equipment

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