Tech Brief

MAY 2019 FHWA-HIF-18-019

JOINT SEALING

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BACKGROUND AND DEFINITION

Concrete pavements incorporate joints to control cracking and to provide relief for concrete expansion and contraction caused by temperature and moisture changes. Joints are normally created by sawing and then are later sealed or filled to limit the infiltration incompressible materials into the sawcut and underlying pavement system. Joint seals may also limit the infiltration of water into the pavement system. Unless otherwise noted, the discussion of sealing practices considers various concrete pavement joints collectively. Terms associated with joint sealing, illustrated in cross-section in figure 1 (ACPA 2018a), are the sealant (i.e., joint material) and the reservoir (i.e., the cavity within the joint containing the sealant). A backer rod (a compressible material that fits into the joint reservoir) can be employed to help establish a suitable sealant shape factor (or the ratio of the sealant depth to width, which helps minimize stresses on the sealant) and prevent three-sided adhesion.

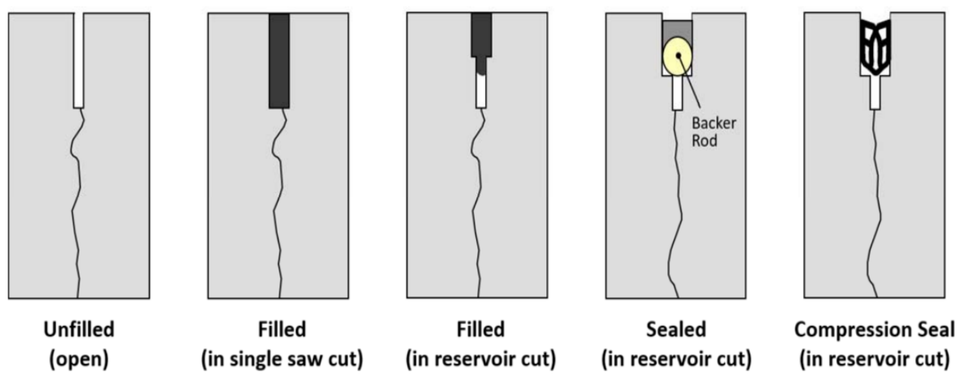


Figure 1. Examples of preformed seals, formed-in-place seals, and joint fillers.

Types of Joint Seals

Joint seals are classified in this brief as formed-in-place or preformed:

- Formed-in-place seals, sometimes referred to as liquid sealants, are either hot-poured (e.g., polymerized/rubberized asphalt materials) or cold-poured (e.g., silicone). Formed-in-place seals sealants must cure and adhere to both sides of the joint to be effective.
- Preformed seals (e.g., neoprene) are slightly compressed into the joint and maintain their position through their contact against the sidewalls of the joint. These sealants are sometimes referred to as compression seals.

An additional method of protecting joints is known as joint filling, with associated products referred to as fillers. Joint fillers are preformed or formed-in-place materials that fill joint sufficiently to prevent the intrusion of incompressible materials. Fillers are distinguished from sealants by the width of the void the filler occupies (i.e. typically a narrow sawcut rather than a reservoir) and filler performance not relying on filler adhesion to the sides of the joint.

Effect of Joint Seals on Pavement Performance

Aside from discussions of cost efficacy, which are not detailed in this brief, the broad view of joint sealing is that it extends the service life of concrete pavements. This view is supported by popular performance benefits, including the following:

- Joint seals limit the amount of surface water entering the pavement system, thereby limiting the risk of pumping, erosion, D-cracking or any manner of deterioration associated with moisture intrusion (see figure 2 from Taylor et al. 2012). By limiting infiltration rates, properly installed and maintained joint seals allow water adequate time to drain from critical locations (e.g., areas near the joint). A study of pavement tests sections in the Long-Term Pavement Performance (LTPP) program indicated that favorable drainage (as characterized by the AASHTO Drainage Coefficient) is a common feature of well-performing jointed plain concrete pavements (JPCP) (Khazanovich et al. 1998). A recent study conducted by Texas A&M University confirmed that if joint seals are properly installed, they can be very effective in preventing moisture infiltration and thus performance issues related to erosion damage (Bakhsh and Zollinger 2016).

(a)

(b)

Source (both): FHWA

Figure 2. Examples of (a) D-cracking and (b) saturated base under a joint in JPCP.

- Joint seals limit the introduction of incompressible materials (such as dirt, rocks, and other debris) from entering and becoming lodged in the joint. During periods of thermal expansion, the presence of these incompressible materials in the joint may lead to localized distress such as spalling or blowups.
- By limiting water intrusion, joint seals also limit the intrusion of deicing chemicals used for snow/ice control in cold climates. The National Concrete Pavement Technology Center (CP Tech Center) found that current deicing techniques contribute to more saturated concrete along joints than occurs in concrete along joints in areas that do not use deicing chemicals (Taylor et al. 2012). This additional saturation, in combination with freeze-thaw cycling, can lead to varied forms of damage and deterioration that are distinct from D-cracking (a common joint degradation associated with the use of saturated frost-susceptible aggregates).
- The benefits and cost effectiveness of joint sealing has been the subject of considerable debate since at least the 1970s. At this time, the need for concrete pavement joint sealing is likely project specific and dependent on the facility type, pavement design (including the drainage, erodibility, and frost resistance of the foundation materials), the local environment, the level of heavy truck traffic, required level of service and performance, as well as other factors (FHWA 2019).

SEALANT STRATEGIES

Many factors should be considered when selecting a suitable joint sealant material, including type of joint and expected joint movements, climate (which impacts required extensibility), bond compatibility with substrate materials (e.g., concrete only or concrete and asphalt [lane-shoulder joint]), chemical compatibility with substrate material (e.g., sensitivity of some silicone sealants to limestone aggregate), need for rapid sealant curing, need for resistance to fuel spills or jet blasts, material and installation costs and expected performance life (FHWA 2019). For highway pavements, silicone and preformed compression seals generally outperform asphalt-based sealants, but often are proportionally more expensive. The use of longer-life sealants should be considered, even with added initial costs, because joint sealant maintenance is often deferred (or ignored) (FHWA 2019).

Once a sealant material is selected, an appropriate reservoir design should be developed for optimum performance of the sealant material. For formed-in-place sealants, this decision may also involve the selection of a backer material (as appropriate, depending on the type of application) to prevent the sealant from displacing into the pavement layers. The subsections below describe this process in more detail.

Material Selection Factors

Initial material selection relies on three factors:

- Joint behavior should be estimated based on a combination of climate and joint spacing. Conservatively estimating joint movement is important, as a study of silicone and polyurethane seals in full-scale test sections by the Michigan Department of Transportation indicated peak movements of 0.16 inches (4 mm) after initially estimating joint movement to be 0.065 inches (1.7 mm) (Eacker and Bennett 2000).
- Traffic volume and traffic characterization may also come into play. For instance, the Wisconsin Department of Transportation has observed that higher vehicle speeds may prevent incompressible materials from lodging in the joints (Shober 1996).
- Life-cycle cost analysis should be conducted to assess the costs of initial sealing and resealing over the pavement life. In general, hot-poured sealants provide 3 to 8 years of service life after installation, silicone sealants provide 8 to 10 years of life, and preformed seals may provide up to 20 years of service (ACPA 2018a). However, preformed seals are the most expensive and hot-poured sealants the least expensive, so these costs and expected service lives must be considered in the selection process along with other factors.

Other Performance Requirements

When selecting a suitable joint sealing product for a paving project, there are a number of relevant sealant properties to consider, including (ACPA 1995; ACPA 2018a):

- The elasticity and modulus of a sealant, which describe its deformability under duress. This parameter is a compromise between two desired properties: the material should be adequately deformable at low temperatures to displace with the faces of contracting slabs, yet it should not be excessively soft at warm temperatures to flow out of the joint nor be damaged by incompressible materials.
- The durability of a sealant, which describes its resistance to deterioration over time due to the environment and traffic.

In addition to these general material property factors, there are specific properties to be considered for formed-in-place sealants (ACPA 1995; ACPA 2018a):

- The adhesion and cohesion of formed-in-place sealants describe their ability to (a) adhere to the sides of the joint and (b) cohere under duress (resist failure within the seal itself).
- Non-sag formed-in-place sealants require manual tooling to force the material against the sidewalls to promote adhesion and configuration. Self-leveling formed-in-place sealants naturally flow into the reservoir and adhere to the faces of the joint.
- Formed-in-place sealants may be selected with a compatible backer rod. If used, a backer rod must be sufficiently compressible to remain at the prescribed installation depth.
- Climate conditions at the time of seal installation.

A summary of common sealant materials, material specifications, and descriptions is provided in table 1.

Table 1. Types of joint seals and related specifications (Smith et al. 2014).

Category	Material Type	Specification(s)	Description
Liquid, Hot-Applied Sealants (Thermoplastic)	Polymerized/ Rubberized Asphalts	ASTM D 6690, Type I (AASHTO M 324)	Moderate climates, 50% extension at 0˚F (-18˚C)
		ASTM D 6690, Type II (AASHTO M 324)	Most climates, 50% extension at -20˚F (-29˚C)
		ASTM D 6690, Type III (AASHTO M 324)	Most climates, 50% extension at -20˚F (-29˚C) with other special tests
		ASTM D 6690, Type IV (AASHTO M 324)	Very cold climates, 200% extension at -20˚F (-29˚C)
Liquid, Cold/Ambient-Applied Sealants (Thermosetting)	Single-Component Silicone	ASTM D 5893, Type NS	Non-sag, toolable, low modulus
		ASTM D 5893, Type SL	Self-leveling, no tooling, low modulus
	Two-Component Elastometric Polymer (polysulfides, polyurethanes)	Fed Spec SS-S-200E, Type M	Jet-fuel resistant, jet-blast resistant, machine-applied fast cure
		Fed Spec SS-S-200E, Type H	Jet-fuel resistant, jet-blast resistant, hand-mixed retarded-cure
Solid, Cold/Ambient-Applied Sealants	Polychloroprene Elastomeric (Neoprene)	ASTM D 2628	Jet-fuel resistant preformed compression seal
	Lubricant	ASTM D 2835	Used in installation of preformed compression seal
Expansion Joint Filler	Performed Filler Material	ASTM D 1751 (AASHTO M 213)	Bituminous, non-extruding, resilient
		ASTM D 1752, Types I-IV (AASHTO M 153)	Sponge rubber, cork, and recycled PVC
		ASTM D 994 (AASHTO M 33)	Bituminous
Backer Rod (if used)	Backer Rod	ASTM D 5249	For hot- or cold-applied sealants

Note 1: ASTM D 1190 was withdrawn in 2002 and replaced with ASTM D 6690 (Type I).
Note 2: ASTM D 3405 was withdrawn in 2002 and replaced with ASTM D 6690 (Type II).
Note 3: The use of preformed compression seals in resealing operations will depend on the condition of the joints.
Note 4: Only closed-cell backer rods are recommended. A few agencies no longer use backer rods because of concerns that they trap moisture in the joint.

Reservoir Shape and Properties

The shape of the joint reservoir is first dependent upon the amount of joint movement. State agencies specifications for joint width may be considered alongside estimates of joint movement. Resources such as ACPA's online app for joint movement (ACPA 2018b) consider joint spacing, base type, concrete coefficient of thermal expansion, drying shrinkage, the temperature at the time of sealing, and the annual low temperature to predict the amount of anticipated joint movements. Assuming typical values for these joint properties, typical joint movements can range between 0.10 and 0.25 inches (2.5 to 6 mm). Examples of agency estimates of these factors can be found in Eacker and Bennett (2000).

Once an estimate of joint movement is obtained, the appropriate width of the reservoir can be developed with an idea of the dimensions or deformability of the selected sealant or filler, as summarized below:

- For hot-poured sealants, the ability of the sealant to "extend" across a range of temperatures must be considered. For a sealant product with an extensibility of 50 percent, a project with estimated joint movement of 0.25 inches (6 mm) requires a joint width of no less than 0.50 inches (13 mm) to permit the sealant to deform properly. If a product with 200 percent extensibility was used for the same joint and estimated movement, the joint width could instead be 0.125 inches (3 mm).

- For formed-in-place sealants such as silicone, the manufacturer's recommendations should be followed for determining the proper width of sealant given the amount of estimated joint movement. However, the agency should evaluate these recommendations in light of their own unique conditions. Typically, a silicone sealant with anticipated movement of 0.25 inches (6 mm) would require a minimum joint width of 0.50 inches (13 mm).
- For preformed sealants such as compressible neoprene seals, the joint movement also dictates the reservoir width. Manufacturer recommendations for the selected compression seal account for the joint width, and typically preformed seals are to be installed so that remain compressed between 20 and 50 percent of their undeformed shape.
- For rigid joint fillers, such as rubber or cork, the filler may not require a reservoir but may instead be directly inserted into void created by the original sawcut.

Once the reservoir width is accounted for, the shape factor is then used to determine the required depth of sealant. As defined previously, the shape factor is the ratio of the joint depth to joint width (W:D), and its selection will depend on the type of sealant. Recommendations for the selection of the shape factor are as follows:

- A shape factor of 1:1 is recommended for asphalt sealants, while a shape factor of 2:1 is recommended for silicone sealants (ACPA 2018a; Evans, Smith, and Romine 1999). Thus, for a joint width of 0.50 inches (13 mm), a hot-poured seal would have a sealant depth of 0.50 inches (13 mm), whereas a silicone seal would require a sealant depth of 0.25 inches (6 mm).
- For preformed seals, the shape factor is dictated by joint movement and the required depth to accommodate the selected compression seal product. Typical minimum reservoir depths for compressed seals range between 1.5 and 2.0 inches (38 and 50 mm) (ACPA 2018a).

When specified, it is important that a suitable backer rod material be employed. The use of Closed-cell, non-absorptive backer rods are recommended and their compatibility with the sealant material should be confirmed prior to use. Open-celled materials are to be avoided because they hold moisture (ACPA 2018a).

JOINT SEALING PROCESS

Effective sealant installation depends upon proper joint preparation, including joint sawing and joint cleaning. The following subsections describe the steps in the process and potential issues that may be encountered.

Joint Sawcutting

The reservoir that will contain the joint sealant is formed through initial or secondary sawcutting. Traditionally, joint seals are installed in the reservoirs created by a secondary sawcutting operation that produces a wider joint to accommodate the appropriate joint shape factor. This secondary sawcut can be made as part of the initial sawcutting or performed as a separate operation. Some important considerations for the initial and/or secondary sawcutting are:

- The saw cutting must produce a reservoir with sufficient depth for the designed reservoir shape, backer rod, and additional room required to recess the sealant to a certain depth within the reservoir (as presented previously in figure 1).
- A watery mix used to cool the cutting blade can leave a heavy residue on the face of the joint and significantly decrease the bond strength between the sealant material and the joint (Bakhsh and Zollinger 2016). The newly cut reservoir should be cleaned immediately after sawing, regardless of sealant installation plans (FHWA 2019).

Plans to seal joints for a given concrete paving project do not affect conventional joint sawing practices for contraction joints, and typical agency practices for the initial joint cut should be followed in method, timing, and sawcut depth.

As noted above, joint fillers can be installed directly into the original (unwidened) sawcut (ACPA 2010). However, a second sawcut may still be used to create a reservoir for the filler material. In this case, while a formal joint shape factor is typically not adopted, the filler material should be considered alongside anticipated joint movement and other factors.

Reservoir Preparation

Prior to sealant installation, the reservoir should be cleaned to remove debris from the joint. This can be done in a number of ways, including airblasting, sandblasting, and waterblasting, as specified by the sealant manufacturer and/or highway agency (ACPA 2010). When using airblasting, it is important that the air stream is free of lubricants, as any oil film on the faces of the reservoir can interfere with proper adhesion (ISU 2004). For similar reasons, the joint sidewalls should be allowed to dry sufficiently after waterblasting, as moisture can limit the adhesion of formed-in-place sealants.

Immediately after cleaning, the backer rod, if required, should be installed. Considerations in the installation of backer rods are described below:

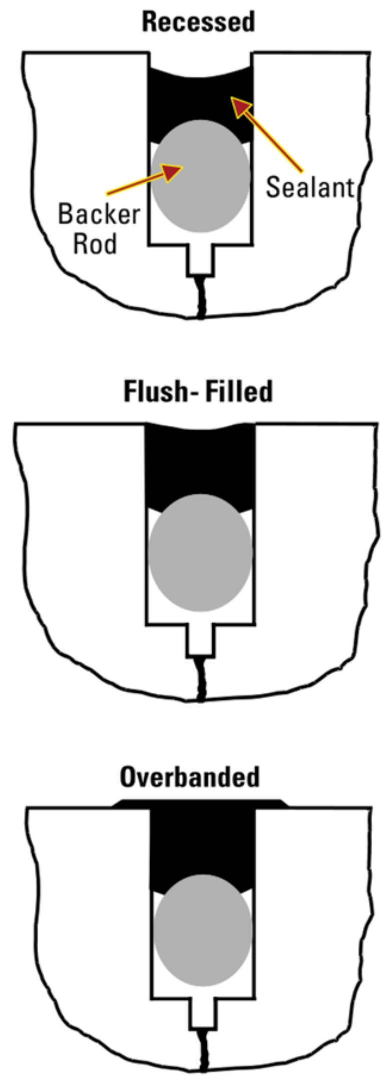
- The backer rod diameter should be roughly 25 percent larger than the reservoir width. A snug fit prevents the backer rod from displacement during installation.
- The backer rod should be compressed into the reservoir at the depth that provides the designed reservoir shape. The backer rod is typically pressed into the reservoir with a roller device.
- Sufficient backer rod material should be available so that it is installed over the entire length of the joint in its relaxed state. The backer rod should not be stretched more than about 5 percent of its length.
- The backer rod used with hot-poured sealants should tolerate the specified application temperature of the sealant. ACPA (2018a) notes that while heat-tolerant open cell backer rod products may not melt in contact with hot-poured sealants, these open cell products can retain moisture in a way that contributes to detrimental performance.

As mentioned previously, some agencies may elect to forego backer rod and fill the entire reservoir cavity with a hot-pour sealant (Taylor et al. 2012). Regardless, the sealant should be installed as soon as possible after reservoir preparation. The finished reservoir should be clean and dry. Methods to accelerate drying should consider that the concrete at the joint is hydrating. Thus, compressed air is acceptable, whereas the use of a blow torch is not.

Sealant Configuration

Sealants can be placed in the joint in a number of different configurations, as shown in figure 3. These configurations are described below:

- Most hot-poured sealants are placed in recessed configurations, where the top of the reservoir is roughly 0.12 to 0.25 inches (3 to 6 mm) below the pavement surface. This configuration prevents the sealant from being removed in high traffic installations. Silicone sealants should be placed in the recessed configuration only.
- Flush-filled configurations are those in which the hot-poured sealant is flush with the pavement surface. This configuration is recommended by some manufacturers as it eliminates a reservoir area for incompressibles to collect and helps the sealant remain more ductile as it is subjected to the kneading action of passing tires (Smith et al. 2014).
- Overband configurations involve overfilling the reservoir slightly to form the configuration shown in figure 3 (Smith et al. 2014). While this method maximizes the bonding surface area between the sealant and pavement, it is susceptible to snowplow damage and can negatively affect ride quality (Evans, Smith, and Romine 1999). Therefore, it is not recommended for most joint sealing applications.



Source: FHWA

Figure 3. Types of joint sealant configurations.

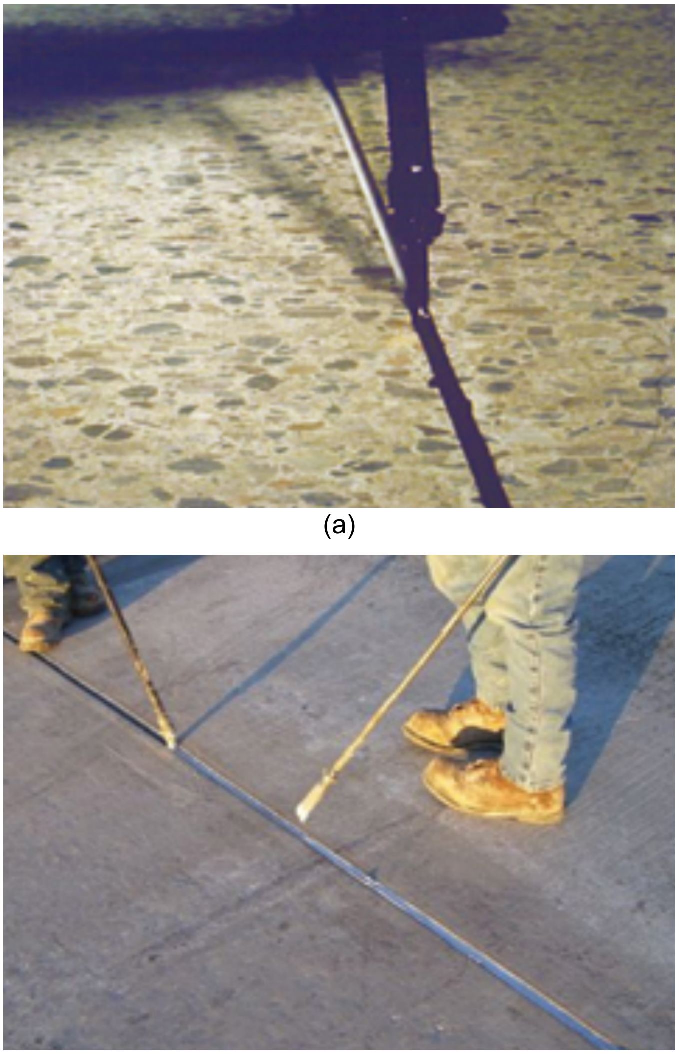
As noted previously, Taylor et al. (2012) indicates that some agencies exclude the backer rod when using hot-poured sealants. In these cases, the majority of the reservoir is filled by the sealant material, although the degree to which this is achieved depends on the width of the joint.

Sealant Installation

Hot-Poured Sealants

The installation of hot-poured sealants requires that they be heated to temperatures 350 ºF (177 ºC) and higher prior to application (APCA 2018a). Because of these extreme temperatures, rapid cooling of the hot-poured sealant during application should be avoided, and it is recommended that the installation should be conducted at a minimum ambient temperature of 40 ºF (4 ºC) (FHWA 2002). At the same time, the sealant should not be overheated, as this can adversely affect sealant performance. The manufacturer’s recommendations should be consulted for the proper heating and thermal management of the sealant.

The hot-poured sealant is typically placed into the reservoir using a wand (see figure 4a from Smith et al. 2014). The sealant should fill the reservoir uniformly, and the reservoir should be filled in a "bottom-up" manner to avoid trapping air bubbles. As hot-poured materials are self-leveling, no additional installation effort is required beyond filling the reservoir to the desired level.



(a)

(b)

Source (both): FHWA

Figure 4. (a) Hot-poured and (b) silicone sealant installations.

Silicone Sealants

Silicone sealants are caulked into the reservoir in a bottom-up manner similar to hot-poured sealants to limit trapped air. Silicone sealants are available as self-leveling and non-self-leveling products:

- The most popular silicone sealants are non-self-leveling and must be tooled into the reservoir so that it adequately adheres to the faces of the joint and contacts the backer rod. The tooling device is typically a hose or large-diameter backer rod that smooths the silicone into the reservoir and against the joint sidewalls (see figure 4b from Smith et al. 2014).
- Self-leveling sealants do not require tooling but instead rely upon the flowability of the material to settle into the joint reservoir created by the uniform joint width and proper backer rod installation.

Both tooled and self-leveling silicone sealants must be finished in a recessed configuration, as described previously (Evans, Smith, and Romine 1999; Smith et al. 2014). Silicone sealants require adequate curing time prior to opening to traffic. Manufacturer recommendations for application, depth of recessed configuration, and curing time should be followed.

There are other formed-in-place sealants available for sealing concrete joints, such as polyurethane or polysulfides, but their use is far less common. More details on the installation of these sealant types can be found in Collins et al. (1986) and Gurjar et al. (1997).

Preformed Seals

A cross-section of a preformed neoprene seal was shown earlier in figure 1. The proper installation of these seals is relatively straightforward, as they have no special thermal or curing requirements. Instead, these seals are compressed into the reservoir and remain in that state of compression over their service life. Thus, it is important that the compression seal is properly sized for the joint, and it is not uncommon

Adequate compression creates a secure seal between the faces of the reservoir and the neoprene sealant. To be effective, the neoprene seal should maintain a state of compression, typically between 20 and 50 percent of its undeformed size (ACPA 2018a). Thus, ambient temperature at installation is important. Because the seal should be in compression even during cold temperatures, the seal may need to be installed at 50 percent compression if seasonal low temperatures are significantly lower than the installation temperature.

To install (compress and insert) the neoprene seal without damaging it, the seal is often lubricated prior to insertion. If it is installed straight and vertically into the joint, the use of lubrication should allow the seal to compress adequately.

Joint Fillers

Rigid joint filler products such as cork or sponge rubber are compressed and installed in a manner similar to preformed seals. These materials are formed and compressed when installed and do not require lubrication or significant force to install. After installation, the filler will expand beyond its installation thickness as it absorbs humidity and water, thereby filling the sawcut and preventing the intrusion of materials.

Hot-poured materials such as asphalt can also be used as a joint filler. Their installation differs from formed-in-place sealants in the sense that filler adhesion to the sides of the sawcut is not critical to filler performance, as a filler limits the intrusion of incompressible materials but not the intrusion of water.

Potential Issues

Many common issues in sealant installation can be avoided through careful preparation and installation:

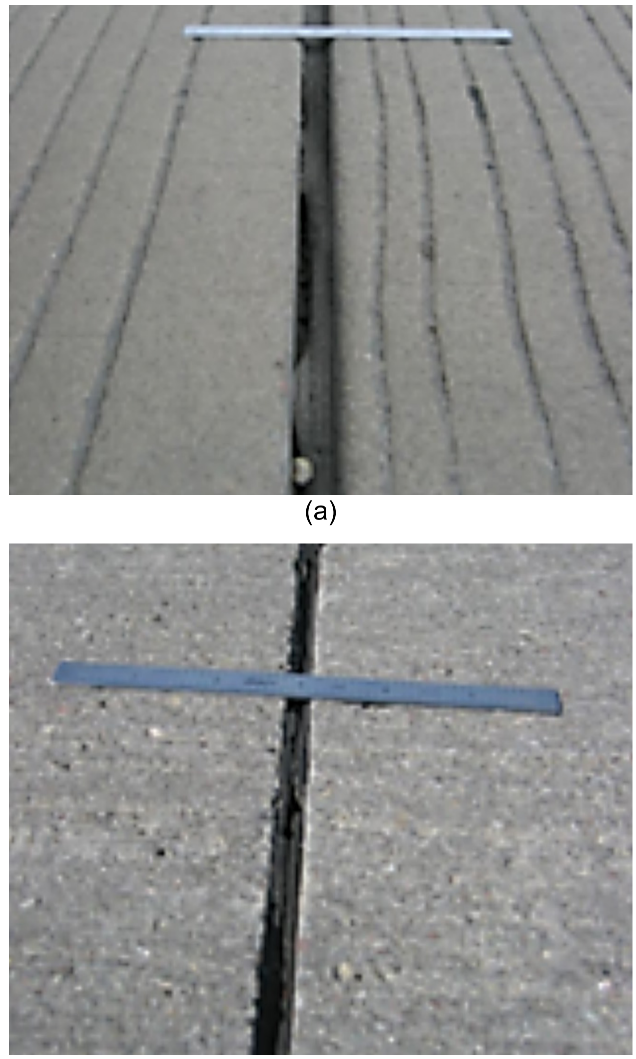
- Poor adhesion of the sealant to the faces of the joint can be attributed to issues in design or cleaning. An unclean or moist surface at the time of installation may interfere with proper adhesion of the sealant to the faces of the joint. A reservoir shape that is too shallow may not provide sufficient surface area for bonding between the concrete and sealant, and during joint movement the bond may consequently fail.
- Poor adhesion of the sealant can also be attributed to issues relating to temperature. As noted, it is recommended that the joint sealant is installed in temperatures no less than 40 ºF (4 ºC). Insulated hoses and recirculation lines can be used to prevent the hot-poured sealant from dropping below the manufacturer's recommended installation temperature (US DOD 1993). And, as previously noted, hot-poured sealants may fail to adhere due to overheating, which damages the sealant itself.
- The use of backer rod may trap unwanted moisture in the area between the rod and the bottom of the reservoir (ISU 2004). This trapped moisture may lead to early damage and possible cavitation at the bottom of the reservoir. This issue can be avoided by allowing joints to dry and making sure that sawcuts are clean.
- Loose compression seals can result from either unanticipated joint movement, varied joint sawing, damaged seals, or improperly sized compression seals.

JOINT SEALANT DAMAGE

Types of Damage

Damage to the joint sealant can occur given the total surface area between joint faces and sealants, traffic levels, and unanticipated joint movement. Some common examples of sealant damage include:

- Natural aging of the sealant material, particularly for hot-poured sealants, will lead to a performance loss. This aging can be due to oxidation of asphaltic materials or exposure of silicone/polymers to ultraviolet radiation. A concern for aging in joint sealants is that, as the materials age, they become more brittle and less pliant in the joint.
- Loss of adhesion between the sealant and either face of the joint, as illustrated in figure 5a (Smith et al. 2014), can significantly reduce the performance of the sealant. This failure forms regions for water to penetrate the joint. In cold climates, freeze-thaw cycling of this water can lead to further damage to the seal. Gaps between the sealant and the joint face can also be penetrated by road debris, which can lead to additional loss of adhesion.
- Sealant materials that are of insufficient depth (i.e., too shallow) or materially compromised (e.g., overheated hot-poured products) can fail in cohesion, shown in figure 5b (Smith et al. 2014). Much like loss of adhesion, this introduces water and materials into the reservoir and joint.



(a)

(b)

Source (both): FHWA

Figure 5. (a) Adhesion and (b) cohesion damage in joint seals.

- As discussed, joint movement must be accounted for, but in doing so, there is still risk of damage from joint movement. Incompressible materials can still rest at the surface of the sealant when the joint is in a contracted state, and when the slabs expand (closing the joints), the presence of the incompressible materials can create forces that may lead to joint spalling. Even minor spalls (or "sliver" spalls) can lead to additional damage that compromises the seal, which may in turn expose the joint and lead to more severe spalling (as depicted in figure 6 from ACPA 1995).

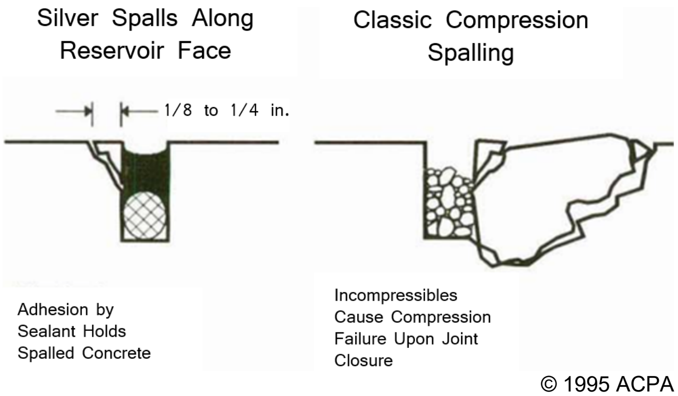


Figure 6. Schematic illustrations of joint spalling.

Preventing Damage

Proper material installation is the most important step to preventing early sealant damage. Later damage—due to factors discussed previously—can be minimized through regular condition surveys of installed seals and local repairs (resealing) where required:

- Intervals for condition surveys are left to the discretion of the agency. ACPA (1995) recommends survey intervals presented in table 2.
- A thin metal strip can be used to check for the loss of adhesion along the joint face. By lightly inserting the strip at the interface of the face and sealant, the adhesion can be assessed. Where adhesion loss has occurred, the edge of the strip may be used to examine the failed portion of the seal for debris such as dust and sand (ACPA 2018a).
- Areas where the sealant has failed in cohesion should also be tested with a metal strip, to determine the depth of failure and if materials have entered the failed sealant.
- In cold regions where regular winter maintenance is required, joint brooming prior to surveys may be necessary to remove sand and assess the sealant condition. In these cases, judging the intrusion of incompressible materials may be difficult.
- Areas where joint faulting and spalling have occurred should be closely inspected. These areas can experience a larger volume of water and materials penetrating the joint, and failed seals in these areas may exacerbate faulting.
- Sliver spalls and popouts should be distinguished if possible. Sliver spalls do not necessary harm the sealant, but they should be examined to understand the sealant condition (ACPA 2018a).

Ideally, local damage to sealant would be replaced as it noted in surveys, although it is recognized that the need for traffic control and other concerns limits the ability to address all damaged joint seals in a timely manner. More details on joint resealing considerations is presented in the next section.

Table 2. Joint seal monitoring intervals (ACPA 1995).

Joint Spacing, ft (m)	Measurement Interval	Number of Joints	Area
<12 (<3.7)	Every 9th joint	>85/mi (>50/km)	20%*
12-15 (3.7-4.6)	Every 7th joint	85-70/mi (50-43/km)	20%*
15-20 (4.6-6.1)	Every 5th joint	70-50/mi (43-33/km)	20%*
20-30 (6.1-9.1)	Every 4th joint	50-35/mi (33-22/km)	20%*
>30 (>9.1)	Every 4th joint	35/mi (22/km)	20%*

*Surveyors should select an area (sample unit) that represents the average condition of the pavement in question.

JOINT RESEALING

Applications

When pavement condition surveys determine that joint sealant damage is systemic rather than local, joint resealing operations should be conducted on an otherwise well-performing pavement to restore joint seal functionality. State agencies may have specific limits of failed joint seals to consider, along with cost and traffic control considerations, to assist in this decision (ACPA 2018a; Evans, Smith, and Romine 1999).

Selecting Materials and Equipment for Resealing

The selection of sealant for a joint resealing project is similar to the selection of a new sealing project, but one primary difference is that preformed seals are not typically used in resealing operations. An older pavement, even when in good condition, can present some issues for preformed seals, most notably in terms of variable and non-uniform joint widths and the presence of joint spalling.

Construction Considerations

The resealing process has two additional steps that precede the new sealing process described above. Those additional steps are (1) the removal of the old sealant material, and (2) the refacing the reservoir to accept new seal material. Once these steps are complete, the joint resealing follows the previously described steps of joint cleaning, preparation, and material installation.

Removal of Old Sealant

The removal of the old sealant can be done using either a rectangular joint plow (see figure 7a) or using a diamond-bladed saw during the joint refacing operation (see figure 7b). The latter has come into more widespread use as it is more efficient and does not damage the joint.

Joint Refacing

Refinishing the faces of the joint reservoir, or "refacing," provides a clean, continuous surface to which the replacement sealant can effectively bond with the concrete. Refacing operations typically use a diamond-blade saw, but because of the need to slightly widen the joint, multiple blades should be on hand to provide the desired cutting width. Smith et al. (2014) recommend that refacing should widened the reservoir by no more than 0.08 inches (2 mm) to speed operations and limit the joint width after multiple resealing operations.

Preparation and Installation of New Sealant

After refacing the joint reservoir, the remaining steps in the resealing process follow the preparation and installation steps detailed above for the installation of new joint seals. Provided that an appropriate material has been selected in the planning for resealing, no additional challenges should be presented in resealing when compared with the preparation and installation of the new sealant.

(a)

(b)

Figure 7. Removal of old joint sealant: (a) joint plow and (b) diamond-bladed saw.

SUMMARY

Proper joint sealing or filling (design/installation/maintenance) has been shown to reduce or slow the likelihood of distresses and contribute to ride quality over the pavement service life. As discussed in this Tech Brief, given proper seal material and sizing, the challenges in joint sealing are mainly those of proper planning and diligence in construction. By working toward quality construction in joint sealant installation, the contractor will limit the failures in sealants that eventually contribute to larger distresses such as spalling.

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