PDHonline Course S173 (1 PDH)

Concrete Maintenance Guidelines

Instructor: John Poullain, P.E.

2012

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone & Fax: 703-988-0088
www.PDHonline.org
www.PDHcenter.com

An Approved Continuing Education Provider

or not. The Caltrans criterion for a working crack is ≥ 1/4 inch of horizontal movement annually. Vertical movement is not usually calculated although it may affect sealant performance. Working cracks can be transverse or longitudinal to the pavement, but are most often transverse. Working cracks with limited spalling or edge deterioration should be sealed, rather than filled. Crack sealing requires thorough crack preparation and typically uses specialized or high quality materials; it should perform longer than crack filling.

When cracks are not working, or when cracks are closely spaced and have little movement, less costly crack filling may be an acceptable alternate to sealing. Filling is considered to be a relatively short-term treatment, but may serve well for low volume pavements. Crack filling typically involves less crack preparation than sealing and performance requirements for filler materials may be lower.

4.4.7 Typical Item Codes

Typical item codes for a joint resealing and crack sealing project are given in Table 4-2.

Table 4-2 Typical item codes for a joint resealing and crack sealing project

Item Code	Description
066074	Traffic control
066075	Signs and traffic control
066076	Temporary traffic control
404001	Clean and seal pavement joint
413114	Replace joint seal (existing concrete pavements)
413115	Seal joint (existing concrete pavements)
414091	Seal longitudinal joint
414101	Seal transverse joint
414105	Seal random cracks
414111	Rout and seal random cracks
066398	Crack sealant
066515	Repair existing joint damage

Note: Standard special provisions must be followed for specific item codes proposed for the project.

Caltrans Standard Materials and Supplemental Work Item Codes can be found at the following web site:

http://i80.dot.ca.gov/hq/esc/oe/awards/#item_code

4.5 CONSTRUCTION PROCESS

Proper preparation of joints and cracks and installation has been proven to be critical to the long term performance of the selected sealant or filler. Attention to detail is important. The required steps for successful joint resealing and crack sealing with liquid sealants are listed below and are detailed in this section.

- Remove old sealant
- Shape reservoir / reface joint
- Clean the reservoir

- Install backer rod
- Install sealant

4.5.1 Traffic Control and Safety

The traffic control plan for joint and crack resealing shall be prepared in accordance with the Caltrans Safety Manual and the Caltrans Code of Safe Operating Practices. The signs and devices used must match the traffic control plan. The work zone must conform to Caltrans practice and requirements set forth in the Caltrans Safety Manual and the Caltrans Code of Safe Operating Practices and any other pertinent requirements. Each worker must fully equipped with the required safety equipment and clothing. Signage shall be removed when it no longer applies.

Depending on the project location, size, and amount of work, one of the following types of traffic control alternatives may be considered:

- Complete roadbed closure
- Continuous lane closure
- Weekend closure
- Nighttime closure

A more detailed description on the traffic control is provided in Section 1.5.4.

4.5.2 Equipment

Equipment for preparing and cleaning joints and/or cracks includes: rectangular joint plows, diamond saws, high pressure air and/or water blaster(s), and sandblaster.

A joint plow is a blade that is mounted on the hydraulic mount of a tractor or the bucket of a skid loader that can move vertically and horizontally in the joint without binding. The plow blade is inserted into the joint and pulled along each joint edge to scrape the sealant off the joint faces. To avoid damaging the joint faces, the blade must be rectangular and fit freely into the joint. Caltrans does not allow V-shaped plows. Blades of several widths should be on hand, as joint widths are seldom uniform over an entire project.

Diamond-bladed saws are water-cooled devices equipped with diamond-edged blades. A single, full-width blade is useful for maintaining joint width; however, the edges wear quickly, reducing the effectiveness of the sawing. Two blades separated by a spacer to the desired width can be used on the same arbor, but the blades are thinner and may warp if overheated.

Power-driven wire brushes should not be used to remove old sealant or to clean PCC pavement joints. Airblasting equipment consists of high-pressure air compressors with hoses and wands. High-pressure air compressors are effective at removing dry dust and debris from a joint. Caltrans SSPs require a minimum compressed air delivery rate of 120 cubic feet per minute, with a minimum nozzle pressure of 90 psi. The air shall be free of oil and moisture.

Sandblasting equipment is used to remove laitance, remaining debris and remnants of old sealant. It includes a compressed air unit, a sandblasting machine, hoses, and a wand with a venturi-type nozzle. Caltrans SSPs do not distinguish between compressed air requirements for airblasting and sandblasting.

Air compressors must be equipped with working water and oil traps to prevent contamination of the joint faces. To ensure oil or water free operations, compressors should be tested using a clean white cloth.

Equipment for sealer and/or filler installation includes: melters for hot applied materials, and pumps and applicators for respective hot and cold-applied materials.

Melters are used to heat and mix hot-applied thermoplastic materials. These machines burn either propane or diesel fuel, and the resulting heat is applied to a transfer oil that surrounds a double-jacketed melting vat containing the sealant material. This apparatus provides a controlled and uniform heat (350-400ºF) for application. Temperature control is required to avoid overheating and degradation of the sealant. Agitators are required for asphalt rubber sealants.

Compressed air-powered silicone pumps are used to pump one-component silicone materials from storage containers for application at ambient temperature. A feed rate of at least 0.4 gallon/minute is recommended. The applicator wand is equipped with a nozzle that fits into the reservoir to allow filling from the bottom up.

Applicators for hot-applied sealers are generally pressure-wand systems. Sealant material is pumped directly from the melter tank through the hoses and applicator wand, and into the bottom of the joint.

4.5.3 Remove Old Sealant

Removal of the old sealant material is critical to provide a surface to which the new sealant can bond, especially since the liquids used for resealing work by adhesion to the joint faces. It is important to avoid damaging the joint reservoir during the removal process. Sawing with diamond blades is an efficient method for combining sealant removal and joint refacing steps and has thus become very popular. However, sawing works best for removing somewhat hardened sealants. Sticky, temperature-susceptible materials may gum up the saw blades and/or joint faces. Rectangular joint plows may also be used, or a knife blade can be used to cut the sealer away from the PCC. Caltrans SSP 41-210 allows these three removal methods and also requires removal of backer rods. Contractors are required to submit the proposed removal method for Caltrans review and approval prior to removal.

4.5.4 Shape Reservoir / Reface Joint

If the old sealant was removed by means other than a diamond bladed saw, it may be necessary to perform a separate joint refacing operation using wet or dry sawing with diamond blades. Caltrans allows either single pass or double pass saw cuts for this purpose at the Contractor's option. Use of routers is no longer recommended for refacing joints.

Care should be exercised when refacing. Excessive widening of joint reservoirs may change the shape factor and affect performance of the sealant. Wide joints may also increase the likelihood of "wheel slap" which generates unwanted tire noise.

4.5.5 Clean Joint Reservoir

Cleaning the reservoir is the most important part of joint sealing. Performance of liquid sealants depends on good adhesion of the sealant to the joint faces. Any dust, dirt or old sealant remaining on

the joint faces blocks the new sealant from direct contact and bonding with the PCC. Aside from old sealant, materials that may contaminate the joints include:

- Water-borne debris (laitance) from wet sawing.
- Oil or water blown in by the compressed air stream.
- Dust and dirt left behind by the cleaning operation.
- Material that enters the joint between cleaning and sealing.
- Other contaminants that may inhibit bonding, including moisture condensation.

After joint refacing is completed, the joint should immediately be cleaned with high-pressure air or water, and dried. Caltrans does not allow chemical solvents to be used to wash joints. Cleaning narrow joints (less than ¼-inch wide) is more difficult than cleaning joints that are at least 3/8-inch wide. Sandblasting follows to remove laitance (wet-sawing residue) and any other residue on the joint faces. The resulting surface texture enhances sealant adhesion. A minimum of one pass is required to clean each joint face, and close attention must be paid to the work to ensure consistent, thorough cleaning. Best practice is to angle the air rather than blasting directly into the reservoir. During the sandblasting operation, the operator should use appropriate safety equipment including a proper helmet and breathing apparatus. Following sandblasting, the entire length of each joint face should be visibly clean with the PCC exposed.

Final air blasting should be performed no more than one hour before backer rod and sealant installation. Joints and surrounding surfaces should be air blasted in one direction away from prevailing winds, without contaminating cleaned joints. Care must also be taken not to blow debris into traffic in adjacent lanes. Caltrans requires vacuum removal of the air blasting debris and residue. When compression seals are to be used for sealing restored joints, sandblasting and final air blasting are not required.

4.5.6 Install Backer Rod

Backer rod should be installed as soon as possible after the joints are properly prepared and cleaned. Caltrans requires a minimum air temperature of 40°F and PCC temperature above the dew point for backer rod installation. The backer rod must be a flexible, non-absorptive material that is compatible with the sealant material being installed. Because reservoir widths vary, several different sizes of backer rods should be available. The diameter of the backer rod should be about 25 percent larger than the joint width; if this does not provide a tight seal, a larger diameter rod should be substituted.

It is critical to install the backer rod to the proper depth, with no gaps between backer rod strips. The rod should be stretched as little as possible to reduce the likelihood of shrinkage and development of gaps. Backer rod may be installed using a special steel roller (single or double-wheeled) or other smooth blunt tool that does not puncture or stretch the backer material.

4.5.7 Install Sealant

Immediately before any liquid sealant is installed, the cleanliness and dryness of the joint reservoirs must be verified. Installation requirements may differ for each sealant product, so it is important to understand and follow the manufacturer's recommendations to avoid unnecessary problems. Recommendations may include limits on pavement and ambient installation temperatures, moisture conditions, and/or on curing time before opening the roadway to traffic.

Hot -Applied Sealants

Hot-applied sealant materials should generally be placed when the air temperature is at least 40ºF and rising (FHWA, 2002), but Caltrans requires a minimum installation temperature of 50ºF for asphalt rubber sealants. It is important to follow the manufacturers' recommendations for heating and handling, including maximum sealant temperature, placement temperature, and any limitations on heating time. Many of the polymer- and rubber-modified sealants may break down when heated above the recommended safe heating temperature. Prolonged heating can cause some sealant materials to gel in the heating tank, while others experience significant changes (usually losses) in their elastic properties.

The sealant material should be uniformly installed by filling the joint reservoir from the bottom up and pulling the nozzle toward the installer to avoid trapping any air bubbles, but not overfilling it. Caltrans Standard Plan P 20 shows that the surface of the sealant is to be recessed 3/8" ± 1/16" below the surface of the pavement to allow room for expansion during hot weather without extruding the sealant from the joint. Some manufacturers recommend that the joint be flush filled with sealant. To avoid "tracking" of the sealant, traffic should not be allowed on the newly sealed joints for about 30 minutes to 1 hour after sealant placement. Consult the manufacturer's instructions for information regarding opening to traffic, consider effects of site weather conditions, and evaluate the in-place curing before allowing traffic on the newly sealed joints.

Cold-Applied Sealants

Minimum installation temperature for silicone sealants is generally 40 ºF. Silicone sealants should be installed in the same manner as hot-applied, from the bottom to the top of the joint and pulling the nozzle toward the installer. Minimum placement thickness is ¼-inch, and shape factor may vary from 0.5 to 2.0. Typical curing time is about one hour, but check manufacturer's instructions for specific recommendations about opening to traffic.

Nonself-leveling silicone sealants must be tooled to force the sealant around the backer rod and against the joint sidewalls, and to form a concave sealant surface. Large diameter backer rod and rubber hose have been used for tooling, which should be performed before the sealant starts curing within about 10 minutes of installation.

Self-leveling silicone sealants do not require tooling, but may flow easily around loose backer rod or out at unblocked joint ends prior to curing, so particular care is required during installation of backer rod and sealant. Some agencies have mandated tooling in order to enhance the bond between the pavement and the sealant even if the material does not require it.

NOTE: When installing both silicone and asphalt rubber sealants on a single pavement section, for example, where silicone sealant is to be used in the transverse joints and asphalt rubber in the longitudinal joints, the silicone should be installed first to reduce the potential for contamination of the transverse joint during the longitudinal joint sealing operations (FHWA, 1985). This is not an uncommon occurrence; cold-applied sealants should be installed first, regardless of the orientation of the joint.

Longitudinal Joint Resealing

As previously discussed, there are two types of longitudinal joints in PCC that may be resealed: joints between adjacent PCC slabs, and joints between the mainline PCC pavement and an AC shoulder.

Although the procedures are basically the same as for transverse joint resealing, there are some additional considerations.

PCC to PCC Joints: Longitudinal joints between adjacent PCC slabs are generally tied together with tiebars, which limits slab movements so that conventional joint sealing operations can be conducted. These joints are generally sealed with a hot-applied material, and typically no reservoir is needed or formed. If the transverse joints are to be sealed with silicone, seal them first to prevent contamination by hot-applied sealant material.

PCC to AC Shoulder: Because of the differences in material properties, joints between a PCC mainline pavement and an AC shoulder often experience large differential vertical movements that may be accompanied by considerable horizontal movement and separation along the longitudinal joint. Sealing is required to minimize water infiltration. The primary difference from typical transverse joint sealing operations is that an extra wide reservoir (minimum one-inch, shape factor of 1.0) is cut in the existing HMA shoulder to allow for the anticipated movements. If the reservoir is of uniform depth, a backer rod is generally not needed. Many agencies routinely use hot-applied materials to seal this joint, although some silicone materials have been developed for this application.

Compression Sealing

Compression seals are installed in new and restored transverse joints. Face preparation is limited to identifying any areas of raveling, spalling or other defect that might interfere with sealant compression and allow pop-out or extrusion, and making suitable repairs prior to installing the seals. Installation of compression seals requires application of a lubricant/adhesive to the seal and the joint faces. The seal is mechanically compressed and inserted into the reservoir. Most of the compression seal manufacturers make installation devices, and the most common type is compress-eject machines. These machines have some propulsion, insertion depth control, and a guide to keep them on the joint. They eliminate a number of problems that may be caused by hand installation, such as twisting and stretching. Splicing of compression seal is to be avoided as feasible, as it creates discontinuities; for joints less than 25 feet long, only one piece of compression seal should be used. If used for longitudinal joints, the compression seal should be cut at the transverse joint crossings.

4.5.8 Crack Sealing

Crack sealing in PCC pavements uses the same basic steps as does for joint sealing: refacing, cleaning, backer rod installation, and sealant installation (ACPA, 1993). The first step is to reface the crack to the desired width. However, the orientation of most PCC pavement cracks makes it difficult to create a uniform sealant reservoir directly along the crack. Small diameter diamond-bladed saws have been used successfully (ACPA, 1993) to form reservoirs. The cutting blades for these saws are typically about 7 to 8 inches in diameter and ¼ to ½-inch wide. The width of the saw cut usually yields an appropriate shape factor for the expected crack movement. Smaller blade diameters and some lightweight two- or three-wheel unit designs, allow crack saws to pivot and follow irregular crack profiles. Although the saws are not generally as maneuverable as routers, they don't have as much potential for spalling the crack faces.

After the reservoir is created, the crack should be cleaned as if it were a joint to be resealed. Sandblasting is highly recommended. Then the crack is blown with compressed air and the backer rod (if specified) and sealant material are installed. The same precautions that apply to the installation of sealant materials into joints also apply to crack sealing (ACPA, 1993). Use of epoxy to glue working cracks is not generally recommended, as it often contributes to subsequent adjacent thermal cracking.