Pavement Crack Treatments

Crack Types; and Crack Sealing Versus Crack Filling

Asphalt pavements crack because at least one component of the road is inadequate to support the traffic that moves over it. Whether on the surface or in the subbase, that component has deteriorated enough for a crack to form. Sealing or filling that crack properly should decrease road roughness, and, more importantly, slow the deterioration.

A common and useful scheme to categorize cracks is by their direction relative to road length and width. Longitudinal cracks run lengthwise; that is, parallel to the roadway centerline. They are usually found at construction joints and between traffic lanes. Transverse cracks run perpendicular to the roadway centerline, at least across one full lane width. Generally spaced at regular intervals, they are caused by expansion or contraction of the roadway material.

Sealing or filling does not solve the cause of either longitudinal or transverse cracks. Crack treatment is a form of preventive maintenance; it prevents or reduces, at least for some period, further deterioration of the surface and the base.

Proper crack treatment can provide a useful road surface for two to five years. In general, repairs of cracks caused by an inadequate surface material will last longer than those caused by improper design or a poor base.

Determining the Type of Maintenance

The appropriate type of maintenance for cracked pavements depends on the severity and extent of the cracks. Severity refers to characteristics of crack itself. Extent refers to the relative frequency of cracking. Table 1 shows recommended types of maintenance and repair for various combinations of severity and extent.

Low severity but high extent cracking might best be treated through chip seals or a thin overlay. For very severe cracking of low or moderate extent, spot or partial-depth patching might be best. Finally, moderately severe cracks occurring to a moderate extent might be treated effectively through sealing or filling operations.

In general, high extent and moderate or high severity cracks indicate a very decayed pavement. Crack sealing or filling in these circumstances is both uneconomical and technically unsound in that they do little to delay the need for more extensive corrective actions.

Most road agents or highway superintendents have particular crack treatments they prefer to use and periods during the year when they prefer to use them. They tend to base their practices on the equipment and skills available. Alternative choices, which should at least be considered for longer lasting repairs, are based on overall pavement condition (extent of cracking) or crack characteristics (severity). These might require purchase or lease of equipment and training personnel for its operation.

On occasion, cracked pavements have other characteristics. Edges of cracks might exhibit vertical distresses, such as cupping, lipping, or faulting. They might have significant vertical deflections or movements under traffic loading. Such deficiencies can add significantly to overall pavement roughness and worsen rapidly.

To correct these deficiencies repair alternatives such as patching and/or milling should be considered. In some instances, if the amount of vertical deflection and the severity are not too high, crack treatment might provide a useful road for several years.

Sealing and Filling

Many types of crack treatments have been developed, each for use in a particular situation. They have been grouped, and are described below, in terms of two categories of treatment: crack

Table 1. Guidelines for Determining the Type of Maintenance

<table>
<thead>
<tr>
<th>Severity</th>
<th>Extent</th>
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<tbody>
<tr>
<td>Low: Hairline cracks, little or no spalling</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Nothing</td>
</tr>
<tr>
<td>Moderate: Up to 1/4&quot; wide, some spalling</td>
<td>Crack Treatment</td>
</tr>
<tr>
<td>High: Well-defined, foreign materials, much spalling</td>
<td>Crack Repair</td>
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Extent Low: Overall longitudinal cracking is less than 10% of the section length and/or transverse cracks are 50 ft. apart.

Moderate: Overall longitudinal cracking is between 10% and 30% of the section length and/or transverse cracks are between 25 and 50 ft. apart.

High: Overall longitudinal cracking is over 30% of the section length and/or transverse cracks are less than 25 ft. apart.
sealing and crack filling. Within each category there is a set of treatments which have the same purpose and functions.

Crack Sealing -- The placement of specialized materials either above or into working cracks using unique configurations to prevent the intrusion of water and debris into the crack.

Crack Filling -- The placement of materials into nonworking cracks to substantially reduce infiltration of water and to reinforce the adjacent pavement.

"Working cracks" move, laterally opening and closing and/or vertically with one side rising and falling more than the other. "Nonworking cracks are essentially stable (movements less than 0.1 in). Whether a crack is working or nonworking can generally be determined by its orientation. Working cracks are usually transverse in orientation, and nonworking cracks longitudinal.

Because crack sealing treats moving surfaces while crack filling treats stable surfaces, the objectives of sealing are significantly more difficult to accomplish than those of filling. Sealing requires considerably more planning, greater costs, and the use of specially formulated materials and more sophisticated equipment.

Whether to Seal or Fill

The amount of annual horizontal movement of a crack is the principal basis for determining whether to seal or to fill. In general, working cracks with limited edge deterioration should be sealed, while nonworking cracks with moderate to no edge deteriorations should be filled.

Materials placed in working cracks must adhere to the crack sidewalls and flex as the crack opens and closes. Rubber-modified materials designed for low-stress elongation, especially at low temperatures, perform best in repairs of these cracks.

Nearly all nonworking cracks are longitudinal, but some are diagonal cracks. Because of the relatively close spacing or free edges between longitudinal and diagonal cracks, little movement occurs. Minimal movement permits the use of less expensive, less specialized crack-filler materials.

When to Seal and When to Fill

Ideally, crack sealing is conducted when temperatures are moderately cool (45 to 65°F), which are most common in the spring or fall. Sealing newly developed cracks minimizes dealing with

Figure 1. Material Placement Configurations
deteriorated crack segments (i.e., secondary cracks, spalls) which adversely affect seal performance.

Sealing cracks in moderately cool temperatures is beneficial from two standpoints. First, cracks are partly opened so that a sufficient amount of material can be placed in the crack even if cutting in not performed. Second, the width of the crack channel, whether cut or uncut, is nearly at the middle of its working range. The sealant material will be subjected to a minimum of extension or contraction.

Most crack-filling treatments can be applied year-around, but are best applied during cool or moderately cool weather (35 to 55°F). At these temperatures, cracks are most or all the way open, and operators can insert more material into them.

Like sealing treatments, crack-filling should be applied shortly after nonworking cracks have developed. Filling cracks shortly after they are fully developed delays further growth caused by the collection of debris and/or stripping of asphalt. Use of durable filler materials will reduce the number of repeat applications.

Selecting a Placement Configuration

Sealing and filling treatments can be performed in numerous configurations. The most common are shown in Figure 1 (pages 6 and 7). These configurations are grouped into four categories:

1. Flush-fill
2. Reservoir
3. Overband
4. Combination (reservoir and overband)

In the flush-fill configuration, operators dispense material into the existing, uncut crack, and strike off excess material. Configuration A in Figure 1 illustrates the flush-fill configuration.

In a reservoir configuration, crews place material only within the confines of a cut crack (i.e., crack reservoir). They place the material either flush with or slightly below the pavement surface. Configurations D, F, H, J, and K in Figure 1 are reservoir-type configurations.

In an overband configuration, crews place the material into and over an uncut crack. If the material over the crack is shaped into a band using a squeegee, then the simple band-aid configuration is formed (Configuration B). Leaving the material over the crack unshaped creates a capped configuration.

A combination configuration consists of placing material into and over a cut crack. A crewperson uses a squeegee to shape the material into a

Figure 1. Material Placement Configurations

continued on p. 8
band centered over the crack reservoir. Configurations E, G, I, and L in Figure 1 are combination-type configurations.

Individual configurations are based on four controlling factors.

1. Type of application.
   a. Direct -- Material applied directly to crack channel.
   b. Bond-breaker -- Backer material placed at bottom of crack reservoir prior to material installation in order to prevent three-sided adhesion (i.e., bonding by material to crack reservoir bottom and sidewalls).

2. Type of crack channel.
   a. Uncut.
   b. Cut -- Router or saw used to create uniform crack reservoir.

3. Strike-off or finishing characteristics.
   a. Recessed.
   b. Flush.
   c. Capped.
   d. Band-aid.

4. Dimensions of crack reservoir and/or overband.

In nearly all sealing and filling operations material is applied directly to the crack channel (Configurations A through I). Occasionally, a bond-breaker material, such as a polyethylene foam backer rod, is placed at the reservoir bottom of a working crack prior to sealant application (Configurations J, K, and L). The backer rod prevents sealant material from running down into the crack during application and from forming a three-sided bond with the reservoir perimeter. As a result, the sealant's potential performance is enhanced.

The relative width and depth of a crack influences sealant, and thus treatment performance. The width to depth ratio should be considered during crack-cutting operations and backer rod placement.

Current recommendations are

1. Use rubber-modified asphalt sealants to seal cracks with approximately equal width and depth, and
2. Use silicone sealants when the width is approximately twice the depth.

Sealants in cracks which are very narrow relative to their depth often lose adhesion over periods of temperature fluctuation. Relatively wide and shallow cracks, on the other hand, resist adhesion loss.

Bond-breaker application should be considered only when the following two factors apply.

1. The costs of installing backer rod are anticipated to be lower than the cost-benefits of improved performance.
2. Working cracks are relatively straight (as with joint reflection cracks) and are accompanied by very little edge deterioration.

Most hot-applied, rubber-modified sealants are recommended for direct application; the increased cost of using backer rod with these materials is not justified. Silicone is almost always the only material recommended for placement with backer rod.

A meandering crack is often difficult to follow accurately with cutting equipment. Operators occasionally miss portions of the crack and create two adjacent channels. This presents the dilemma of whether to seal both the cut and uncut crack segments or cut the missed crack segment as well and seal both reservoirs. A similar dilemma arises with secondary cracks along the primary crack.

Routers and saws usually have controls to vary the depth of cut, and the operator determines the width. Backer rod can be placed in deep reservoirs (1.0 to 1.5 in) to a depth that allows for the desired width to depth ratio. This depth normally varies between 0.5 and 0.75 in. The backer rod should be about 25 percent wider than the width of the crack reservoir. It will then maintain its vertical position and provide proper shape for the material.

The decision of whether or not to overband a sealant or filler material depends primarily on the material being used. Some materials, such as silicone and emulsion, simply must not come in contact with traffic. Also, some materials wear away more easily under traffic than others.

If overbanding of hot-applied, rubber-modified asphalt is desired, it also must be decided if the material will be shaped into a band-aid or left as a capped configuration. The latter process generally requires one less laborer, but possibly at the sacrifice of treatment effectiveness. This is because shaping with a squeegee or dish attachment helps establish a "hot bond" for the entire band. In capped configurations, the material may continue to flow and level out after being applied. Bonds created during this self-leveling process are likely to be weaker than "hot bonds" because they will have formed at decreased temperatures.

The dimensions of the band-aid are typically 3 to 5 inches wide and 0.125 to 0.188 inches thick. The simple band-aid configuration (Configuration B) evolved out of a desire to make application quick and easy by eliminating crack-cutting operations. The recessed band-aid configuration (Configuration L) has the best performance of the reservoir-type configurations because the added band provides a wearing surface.