TECHBRIEF

Sealing and Filling Cracks in Asphalt Pavements

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Background

Sealing and filling asphalt concrete pavement cracks is a common road maintenance activity. Specialized materials are placed into or above cracks to prevent the intrusion of water and incompressible material into the cracks and to reinforce the adjacent pavement. To address deficiencies in current crack treatment materials, designs, and practices, the Strategic Highway Research Program (SHRP) and the Federal Highway Administration (FHWA) sponsored the most extensive investigation of crack treatment effectiveness ever undertaken. Monitoring and evaluation of these treatments were performed under the Long-Term Pavement Performance (LTPP) program. Between March and August of 1991, four transverse crack seal test sites and one longitudinal crack fill test site were constructed in the United States and Canada. Upon completion, 6,710 meters of cracks were treated with materials selected for evaluation.

Objectives

The primary objective of the crack treatment experiment was to determine the most effective and economical materials and methods for conducting crack-sealing and crack-filling operations. Secondary objectives included the identification of performance-related material tests and quicker, safer installation practices.

Key Benefits of This Research

The benefits of this study include service life estimates of crack sealants and fillers in asphalt concrete pavements, more cost-effective maintenance operations, decreased exposure of highway workers to traffic, and fewer maintenance delays for the traveling public.

Experiment Design

The test sites were located on highways of moderate traffic volume in four climatic regions. The four crack seal sites were located on the following roadways:

- Interstate 20—Abilene, Texas
  Dry-nonfreeze region

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- State Route 8—Elma, Washington
  Wet-nonfreeze region
- State Route 254—Wichita, Kansas
  Dry-freeze region
- Interstate 35—Des Moines, Iowa
  Wet-freeze region

The longitudinal crack fill site was located at:

- Highway 401—Prescott, Ontario
  Wet-Freeze region

Crack treatment materials and installation methods are outlined in Table 1.

Evaluations

Ten evaluations were performed during the 6.5-year period. The following evaluation parameters were used:

- Weathering
- Pull-outs
- Overband wear
- Tracking
- Extrusion
- Stone intrusion
- Adhesion loss
- Cohesive loss as a result of tensile/shear forces
- Cohesive loss as a result of bubbling
- Edge deterioration

During each evaluation, detailed examinations and measurements were made at each crack to determine treatment effectiveness. Two sets of laboratory tests were conducted. Initial tests ensured that the materials used in the experiment met the specifications maintained by the manufacturer. Supplemental performance tests were intended to strengthen correlations between laboratory-determined engineering properties and actual field performance.

Service Life Comparison

Throughout this study, treatments were subjected to numerous, highly detailed inspections for distresses and failures. For this reason, it was determined that field performance would best be framed in terms of service life, which was defined as the estimated time for a treatment to reach the 75 percent effectiveness level. In other words, the service life is the time required for 25 percent of the crack length to develop failure.

The effectiveness level is simply the failure level subtracted from 100 percent (i.e., 10 percent overall failure equals 90 percent overall effectiveness).

Rating	Effectiveness Level (%)
Very good	90–100
Good	80–89
Fair	65–79
Poor	50–64
Very poor (failed)	< 50

Most of the distresses observed represented a *reduction* in a treatment's ability to perform its function (i.e., to keep water and incompressible materials out of the crack channel). Examples of these distresses include partial-depth adhesion and cohesion loss and overband wear. Some distresses, such as full-depth pull-outs and full-depth adhesion and cohesion loss, signified a treatment's *failure* to perform its function. These latter distresses were termed failure distresses. The total amount of failure distress observed in a treatment formed the basis for performance comparison.

Key Findings

- Of 61 treatments, 32 had failed after the final round of evaluations.
- Half of the eight crack-fill treatments performed favorably after the final evaluation period. The other half failed.
- Generally, the test sites with greater amounts of crack movement and traffic showed lower levels of treatment effectiveness than sites with less crack movement and traffic.

FIGURE 1

Illustration of Service Life Estimation Based on 75% Effectiveness

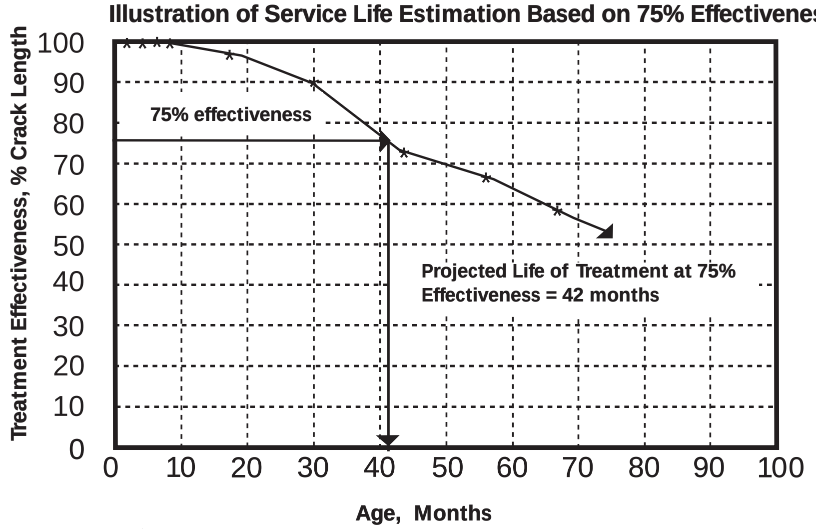

TABLE 1. Estimated Service Life in Months of Tested Crack Treatment Material

Crack Treatment Material	Method[1]	Texas	Kansas	Washington	Iowa	Ontario[2]	Avg.
	Average Estimated Time (in Months) at Which 75% Effectiveness Level Was Reached						
		ADT=10K[3]	ADT=27K	ADT=19K	ADT=14K	ADT=19K	
Meadows Hi-Spec	A-2				57		57
	A-3	58	43	118	61		70
	B-3	78	59	120	82		85
	C-3		56		88		72
	D-3	48	30	120	39		59
	D-4	44	29	95	42		53
Crafco RS 515	B-3	109		120	112		114
	C-3		80		95		88
	D-3	58	33	118	45		64
Koch 9030	B-3	111		120	106		112
	C-3		68		113		91
	D-3	45	24	120	51		60
Meadows XLM	B-3	86		120	114		107
	C-3		70		112		91
	D-3	48	29	119	59		64
Kapelo BF+AC	D-3	9	6	105	19		35
Dow 890-SL	E-5	54	48	109	72		71
Crafco AR+	B-3		52				52
Koch 9000-S	B-3		56				56
Elf CRS-2P	G-4				6		6
Crafco RS 211	B-3			120			120
	H-4					74	74
AC	G-1					42	42
	G-4					42	42
Crafco AR2	D-4					98	98
	G-4					86	86
Hercules FP+AC	D-4					79	79
Witco CRF	G-4					43	43
Hy-Grade Kold Flo	G-4					35	35
Avg. Service Life		62	46	116	71	62	71

Notes: ADT=average daily traffic. K=1,000.

1. The installation methods used were:

Configuration
- A. Standard Reservoir-and-Flush
- B. Standard Recessed Band-Aid
- C. Shallow Recessed Band-Aid
- D. Simple Band-Aid
- E. Deep Reservoir-and-Recess
- F. Standard Reservoir-and-Recess
- G. Simple Flush-Fill
- H. Capped

Preparation Procedure
1. None
2. Wire Brush and Compressed Air
3. Hot Compressed-Air Lance
4. Compressed Air
5. Light Sandblast, Compressed Air, and Backer Rod
6. Compressed Air and Backer Rod
7. Light Sandblast, Compressed Air, and Backer Tape

2. Ontario was the longitudinal crack-fill test site. All others were transverse crack-seal test sites.
3. 2-way ADT, vehicles per day.

- The predominant modes of treatment failure were adhesion loss and cohesion loss.
- The most cost-effective treatments were usually those consisting of rubberized asphalt placed in a standard or shallow-recessed Band-Aid configuration.
- The standard recessed Band-Aid method showed the longest estimated service life, followed very closely by the shallow recessed Band-Aid.

Recommendations

- For short-term crack-seal performance (between 1 and 3 years) in pavements with ordinary working cracks (2.5–5.0 mm of horizontal crack movement) and moderate traffic levels, a standard rubberized asphalt should be placed in a simple Band-Aid configuration.
- For medium-term crack-seal performance (between 3 and 5 years) under the above conditions, either a standard rubberized asphalt may be placed in a recessed Band-Aid configuration or a modified rubberized asphalt may be placed in a simple Band-Aid configuration.
- For long-term crack-seal performance (between 5 and 8 years) under the above conditions, a modified rubberized asphalt sealant should be installed in either a standard or shallow recessed Band-Aid configuration.
- For short-term crack-fill performance (1 to 3 years) in pavements with nonworking cracks (less than 2.5 mm of horizontal crack movement) and low to moderate traffic levels, asphalt cement should be placed in flush-fill configuration.
- For long-term crack-fill performance (between 5 and 8 years) under the above conditions, an asphalt rubber or rubberized asphalt may be placed in either a flush-fill or overband configuration, or a fiberized asphalt may be placed in an overband configuration.
- The importance of quality control in crack sealing and filling operations cannot be overemphasized. Crucial to quality control is an objective, hands-on inspector.

References

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Availability: This TechBrief is based on report No. FHWA-RD-99-143, "LTPP Pavement Maintenance Materials: SHRP AC Crack Treatment Experiment, Final Report." A limited number of copies are available from the R&T Report Center, FHWA, 9701 Philadelphia Court, Unit Q, Lanham, MD 20706; telephone: (301) 577-0818; fax: (301) 577-1421. Copies are also available from the the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

Key Words: Crack seal, crack fill, working cracks, weathering, pull-outs, overband wear, tracking, extrusion, stone intrusion, adhesion failure, cohesive failure.