TECH**BRIEF**

The FHWA Pavement Technology Program is a comprehensive and focused set of coordinated activities. These activities are grouped under five major areas—Asphalt; Portland Cement; Pavement Design and Management; Advanced Research; and Long-Term Pavement Performance. The goal of the program is the development, delivery, and utilization of a broad spectrum of improved technologies that will lead to better-performing and more cost-effective pavements. The program is product and end-result oriented with the intent of significantly advancing and improving pavement technology and pavement performance.

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Pothole Repair

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Introduction

Pothole repair in asphalt concrete pavements is one of the most commonly performed highway maintenance operations. To better understand the performance and cost-effectiveness of various cold-mix materials and procedures for repairing potholes in asphalt concrete-surfaced pavements, the Strategic Highway Research Program (SHRP) undertook the most extensive pavement maintenance experiment ever conducted—the SHRP H-106 project. The project was subsequently continued under the Long-Term Pavement Performance (LTPP) program.

Objective

The primary objective of the pothole experiment was to determine which combinations of materials and patching procedures provide the most cost-effective repair of potholes in asphalt concrete-surfaced pavements.

Experiment Design

Beginning in March 1991 and ending in February 1992, more than 1,250 cold-mix pothole patches were placed at 8 test sites across the United States and Canada. The sites were located on the following roadways and climatic regions:

• I-70, Vandalia, Illinois State Route 25, Vermont Route 2, Prescott, Ontario	Wet-freeze region
• I-15, Draper, Utah US-395, Alturas, California US-97, Medoc Point, Oregon	Dry-freeze region
• FM 1570, Greenville, Texas	Wet-nonfreeze region
• Route 518, Las Vegas, New Mexico	Dry-nonfreeze region

The following patching techniques were used in combination with the various cold mixes:

Throw-and-Roll—Material is placed in a hole, which may be filled with water and debris, and then compacted by four to eight passes the truck tires.

Edge Seal—This is the throw-and-roll procedure plus edge sealing, using asphalt tack and sand on the road surface.

Semipermanent—Water and debris are removed from a hole, the sides are squared up, and cold-patch material is placed in the hole and compacted by rollers or vibratory compactors.

Spray Injection—Water and debris are blown out of a pothole, virgin asphalt and aggregate are sprayed into the pothole, and a layer of aggregate is placed on top of the patch.

A summary of material and procedure combinations used at each test site is provided in Table 1.

Evaluations

The performance of the various combinations of materials and procedures was observed over time to determine which were the most cost-effective repair types. Monitoring of patch performance was done under SHRP until March 1993 and was then continued under the LTPP program. The last evaluation was made in November 1995.

Evaluations were made at 1, 3, and 6 months after the installations were completed, and semiannual inspections were performed for the remainder of the study. Two main types of data were collected during the field performance evaluations. The first type was survival data. This consisted of the number of experimental and control patches still in service along the test site. The second type of data collected gauged the distresses present in the surviving patches. These distresses included bleeding, cracking, dishing, edge disintegration, missing patch, raveling, and shoving.

To identify correlations between material properties and field performance, comparisons were made

TABLE 1. Summary of Material/Procedure Combinations

Material	Procedure	Test Site							
		CA	IL	NM	ON	OR	TX	UT	VT
UPM High-Performance Cold Mix	Throw-and-Roll	✔	✔	✔	✔	✔	✔	✔	✔
	Edge Seal	✔	✔	✔		✔	✔	✔	✔
	Semipermanent	✔	✔	✔	✔	✔	✔	✔	✔
PennDOT 485	Throw-and-Roll	✔	✔	✔	✔	✔	✔	✔	✔
PennDOT 486	Throw-and-Roll	✔	✔	✔		✔	✔	✔	✔
Local Material	Throw-and-Roll	✔	✔	✔	✔	✔	✔	✔	✔
HFMS-2 with Styrelf7®	Throw-and-Roll	✔	✔	✔	✔	✔	✔	✔	✔
Perma-Patch	Throw-and-Roll	✔	✔	✔	✔	✔	✔	✔	✔
QPR 2000	Throw-and-Roll	✔	✔	✔	✔	✔	✔	✔	✔
Spray Injection	Spray Injection	✔	✔	✔	✔		✔	✔	✔
QPR 2000	Edge Seal					✔			
	Semipermanent				✔	✔			
PennDOT 485	Edge Seal					✔			
	Semipermanent				✔	✔			
Local Material	Surface Seal		✔						
	Heat and Tack					✔			

between laboratory test values and mean field performance values, such as survival rating and average distress ratings.

Key Findings

- The throw-and-roll technique proved as effective as the semipermanent procedure when the two procedures were compared directly, using similar materials. The semipermanent procedure has higher labor and equipment costs and lower productivity. Thus, the throw-and-roll procedure is more cost-effective in most situations, if quality materials are used.

- Pothole patches are intended to be temporary repairs, but the success rate observed in this project indicated that materials are available that can remain in service for several years. Overall, 56 percent of all patches survived until the last round of performance monitoring, with 31 percent failures and 13 percent lost, as a result of overlays.

- The spray-injection repairs performed as well as the comparable control patches at all sites. This effectiveness, however, depends on the expertise of the operator.

- Of the eight agencies that participated in this experiment, three have switched from the inexpensive cold mixes they previously used to one of the materials provided through this project. One agency also has purchased a spray-injection device to replace its conventional cold-mix patching procedures.

Recommendations

- Use high-productivity operations in adverse weather. When weather conditions include cold temperatures and precipitation, the prime objective of a patching operation should be to repair potholes as quickly as possible. The throw-and-roll and spray-injection procedures produced high-quality repairs very quickly in all cases. Quality materials should be used with the throw-and-roll procedure, and the spray-injection device should be well maintained and operated by an experienced technician.

- To reduce repatching, use the best materials available. The cost of patching the same potholes over and over because of poor-quality patching material quickly offsets any savings from the purchase of a less expensive cold mix. In most cases, the poorer performance associated with inexpensive cold mixes will result in greater overall costs for patching because of increased costs for labor, equipment, traffic control, and user delay.

- Consider safety and user delay costs in calculating operation costs. When justifying the purchase of a more expensive cold mix, consider the reduced user delay costs that will result when repatching is avoided. Also, consider the improved safety conditions made possible by reduced crew time working alongside.

- Testing should be performed to ensure compatibility of aggregate and binder. Whenever possible, the aggregate and binder to be used to produce a cold-mix material should be tested on a small scale to determine if the two are compatible. This testing is especially necessary when new combinations are being used and there is no record of the patching material's past performance.

Researcher: This study was performed by ERES Consultants, Inc., 505 West University Avenue, Champaign, IL 61820-3915. Contract No. DTFH-93-C-00051.

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