Pavement Preservation for High Traffic Volume PCC Roadways: Phase I Findings From SHRP 2 Project R26

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ABSTRACT

The practice of pavement preservation in general, and preventive maintenance in particular, is a growing trend among transportation agencies around the United States. However, the practice of preservation on high traffic volume roadways is not as well documented as it is on lower volume roadways. Nonetheless, the preservation of high traffic volume roadways is as important as the preservation of lower traffic volume roadways.

Under the direction of SHRP 2, Project R26, *Preservation Approaches for High Traffic Volume Roadways*, was initiated to assess the state of the practice and to provide guidance on pavement preservation for high traffic volume roadways. The ultimate outcome of this study is the development of guidelines that lead to higher volume roadways being maintained in serviceable condition for longer periods of time before rehabilitation is needed, at a lower cost, in a safer manner, and with less disruption to the traveling public. A secondary objective of this study is to identify promising pavement preservation strategies for application on high traffic volume roadways that might not commonly be used, and to make recommendations for further research opportunities.

As part of the first phase of this study, a 24-question survey of practice was distributed to all state highway agencies and Canadian provinces, as well as selected large cities and several agencies in other countries. Ultimately, 57 responses were received. While survey questions addressed both hot-mix asphalt and portland cement concrete (PCC) pavements, this paper focuses on the responses related to pavement preservation on PCC pavements.

INTRODUCTION

The practice of pavement preservation in general, and preventive maintenance in particular, is a growing trend among transportation agencies around the United States. Over the past decade alone, a number of State highway agencies (SHAs) have created or formalized their preservation programs. At the same time, other agencies that might have been practicing preservation for a longer time have extended their programs to cover a greater proportion of their pavement network than ever before while still other agencies are currently in the process of creating formal preservation programs.

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Agencies at the forefront of the preventive maintenance movement have a number of shared practices. For example, several agencies have created a departmental position of Pavement Preservation or Preventive Maintenance Engineer. Many of these same agencies have developed, or are developing, formal guidelines for preservation, such as Caltrans' Maintenance Technical Advisory Guide for rigid pavements (Caltrans 2008). Furthermore, States such as Texas and California have established pavement preservation centers, where researchers and practitioners work together to improve preservation practices. In addition to such centers, States have aligned themselves into regional partnerships to facilitate the exchange of ideas and best practices regarding pavement preservation.

Based on transportation agency practices in this area, the growing significance of preservation practices is indisputable. However, the practice of preservation on high traffic volume roadways is not as well documented as it is on lower volume roadways. There are several possible explanations for this.

- Preservation is simply associated with lower volume roads.
- There is an implied liability problem associated with the failure of certain treatments on higher volume roadways (for example, treatment failures in the 1990s in New York and in the past 6 years in Colorado and Michigan).
- The potential benefit of preservation on higher traffic volume roadways might not be as readily recognized or as well-documented.
- There is a smaller set of materials and procedures that can be employed successfully on high traffic volume roadways.
- Shorter available closure times for busy roadways make treatment construction more complicated.
- Because these pavements are typically designed and built to higher standards than lower volume roadways, they might therefore deteriorate in different ways, rendering typical preventive maintenance treatments less effective.

Nonetheless, the preservation of high traffic volume roadways is as important as the preservation of lower traffic volume roadways, as many of the same conditions hold true:

- Agency resources are limited, and it is important to make the best use of available funding, personnel, and equipment in managing pavements.
- In the long run, pavement preservation saves money.
- Preservation provides benefits to the traveling public, including safer, smoother roads.
- Preservation can be performed more rapidly than rehabilitation, with fewer adverse effects on the traveling public.

Under the direction of SHRP 2, Project R26, *Preservation Approaches for High Traffic Volume Roadways*, was initiated to assess the state of the practice and to provide guidance on pavement preservation for high traffic volume roadways. The ultimate outcome of this study is to develop

guidelines that lead to higher volume roadways being maintained in serviceable condition for longer periods of time before rehabilitation is needed, at a lower cost, in a safer manner, and with less disruption to the traveling public. A secondary objective of this study is to identify promising pavement preservation strategies for application on high traffic volume roadways that might not commonly be used, and to make recommendations for further research opportunities.

As part of the first phase of this study, a 24-question survey of practice was distributed to all SHAs and Canadian provinces, as well as selected large cities and several agencies in other countries. Information was sought on the following:

- Successful techniques for pavement preservation on high traffic volume roadways currently in use.
- Potentially successful techniques for pavement preservation approaches that are not yet fully deployed.
- Challenges and solutions to implementation on high traffic volume roadways.
- Special considerations for quality control/quality assurance (QC/QA).

Ultimately, 55 responses were received from 102 distributed surveys for a response rate of over 55 percent. As shown in Table 1, respondents include 40 SHAs and 7 provinces.

Table 1
Summary of Survey Respondents

State Highway Agencies			*Canadian Provinces*
Alaska	Louisiana	Ohio	Alberta
Arizona	Maine	Oklahoma	British Columbia
Arkansas	Michigan	Pennsylvania	Manitoba
California	Minnesota	Rhode Island	New Brunswick
Colorado	Mississippi (4)*	South Carolina	Ontario
Connecticut	Missouri	South Dakota	Quebec
Florida	Montana	Tennessee	Saskatchewan
Georgia	Nebraska	Texas	
Hawaii	Nevada	Utah (3)*	*Cities*
Illinois	New Hampshire	Virginia	Phoenix, AZ
Indiana	New Mexico	Washington	San Diego, CA
Iowa	New York	Wisconsin	
Kansas	North Carolina	Wyoming	Texas Turnpike
Kentucky			

* Agencies that submitted multiple responses from various districts within the State have the number of responses indicated in parentheses.

While survey questions addressed both hot-mix asphalt (HMA) and portland cement concrete (PCC) pavements, this paper focuses on the responses related to pavement preservation on PCC pavements. It should be emphasized, however, that some of the questions about agency practices or issues did not differentiate between HMA and PCC.

RESULTS

One of the first issues to consider is what defines a high traffic volume roadway. The survey purposely did not provide arbitrary guidelines, instead asking respondents to define these based on their local practice or policies. Furthermore, a distinction between rural and urban roadways was maintained throughout the survey in recognition of differences in practice that might exist among some agencies. About two-thirds of the respondents said that they use different treatments on rural and urban roadways, and in some respects this differentiation was borne out by the data. As for the "definition" of high traffic volumes, there were broad ranges reported for both rural and urban high traffic volumes, in both cases ranging from average daily traffics (ADTs) of 1,000 to 100,000. However, the trends in the responses to this survey support the use in any further analysis of 5,000 ADT as the cut-off for high traffic volume rural roadways and 10,000 ADT as the cut-off for high traffic volume urban roadways.

Respondents were also asked to identify what factors they considered to be important when selecting preventive maintenance treatments for high traffic volume roadways and to rank these as high priority, medium priority, and low priority. The results are summarized in order below, with the percent of respondents identifying the consideration indicated in parentheses.

High Priority

- Safety concerns (76 percent)
- Treatment cost (74 percent)
- Durability/expected life of treatment (64 percent)

Medium Priority

- Availability of experienced contractor (60 percent)
- Work zone considerations (59 percent)
- Risk associated with treatment failure (57 percent)
- Closure time (57 percent)

Low Priority

- Availability of alternate route(s) (40 percent)
- Noise issues (39 percent)
- Public perception (36 percent)

While respondents could enter information on any treatments, the treatments indicated in Table 2 were provided as being representative of those that could be used for the preventive maintenance of PCC pavements.

Table 2
Summary of PCC Treatments

PCC Treatments
• Concrete joint resealing
• Crack sealing
• Diamond grinding
• Diamond grooving
• Partial-depth concrete pavement patching
• Full-depth concrete pavement patching
• Dowel bar retrofit (load-transfer restoration)
• Thin PCC overlays
• Thin bonded wearing course (e.g., HMA < 25 mm [1 in.])
• Thin HMA overlay (< 40 mm [1.5 in.])
• Drainage preservation

The overall responses on the use of PCC treatments on pavements with traffic volumes greater than 5,000 and 10,000 ADT for rural and urban roadways respectively are summarized in Table 3 and Figures 1 and 2. As part of the analysis of results, the responses were also divided into subsets of "low," "medium," and "high" traffic volumes for rural and urban roadways, and the results are summarized in Figures 3 and 4.

Table 3
Survey Responses of Commonly Used Preventive Maintenance Treatments on PCC High Traffic Volume Rural and Urban Roadways

Rural (≥ 5,000 ADT)	**Urban (≥ 10,000 ADT)**
Treatments used by more than 50% of responding transportation departments:	
Crack seal Partial-depth patching Dowel bar retrofit Drainage preservation	Partial-depth patching Dowel retrofit Drainage preservation
Additional treatments used by more than 70% of responding transportation departments:	
Joint seal Diamond grinding Full-depth patching	Joint seal Crack seal Diamond grinding Full-depth patching

An interesting result is that for most agencies there appears to be very little difference between the use of preventive maintenance treatments for high traffic volume PCC roadways in rural and urban areas. There are several possible explanations for this, including that these treatments are not very sensitive to traffic volumes, that their use is not very risky, and that their performance is deemed to be acceptable under a fairly wide range of conditions.

However, as shown in Figure 4, when different ranges of traffic volumes were considered for urban roadways, some differences did emerge. For example, as traffic volumes increase, the more likely an agency was to use diamond grinding and full-depth patching. Similarly, as traffic volumes increased, the less likely agencies were to use partial-depth patching, dowel bar retrofit, and drainage preservation.

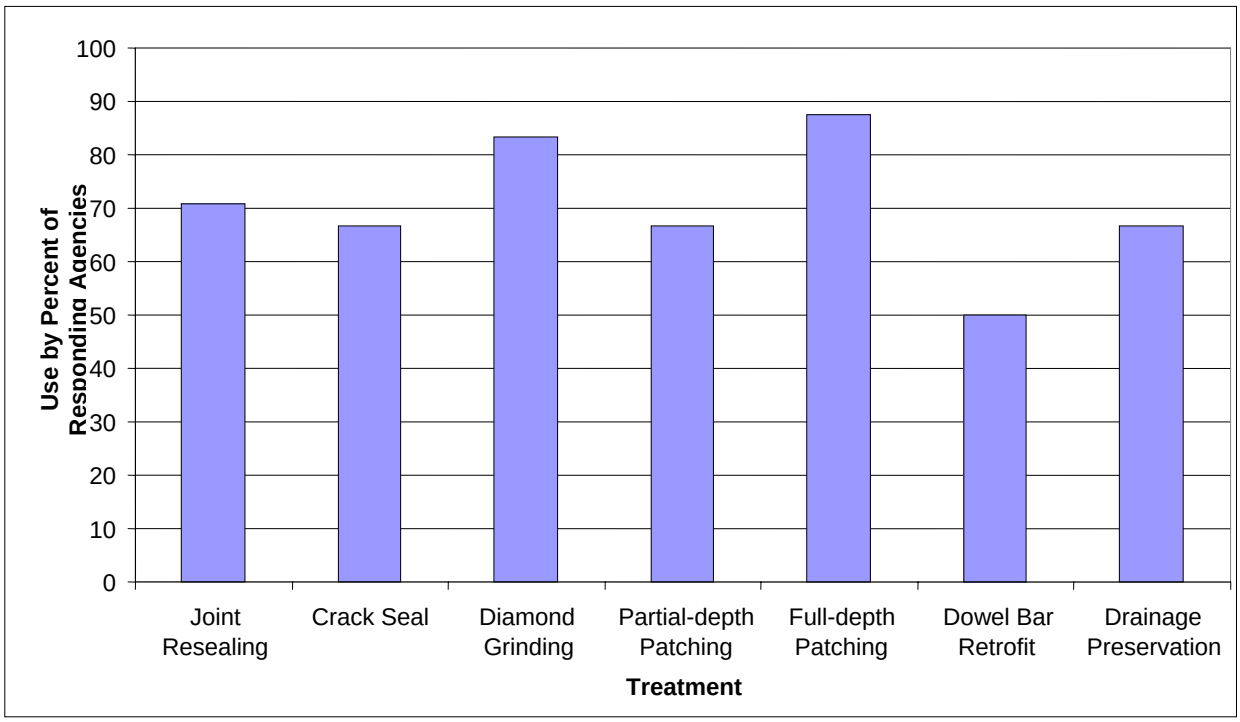

Figure 1. Percent of agencies reporting treatment use on rural high volume traffic PCC roadways (≥ 5,000 ADT).

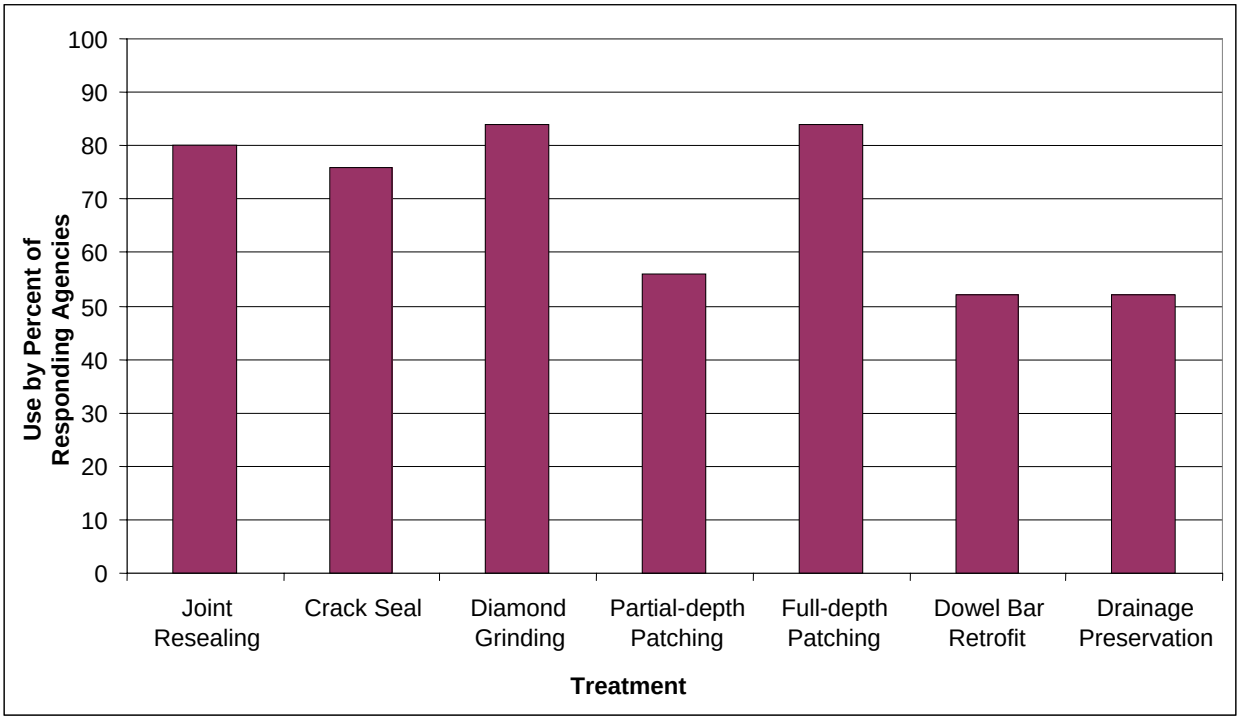

Figure 2. Percent of agencies reporting treatment use on urban high volume traffic PCC roadways (≥ 10,000 ADT).

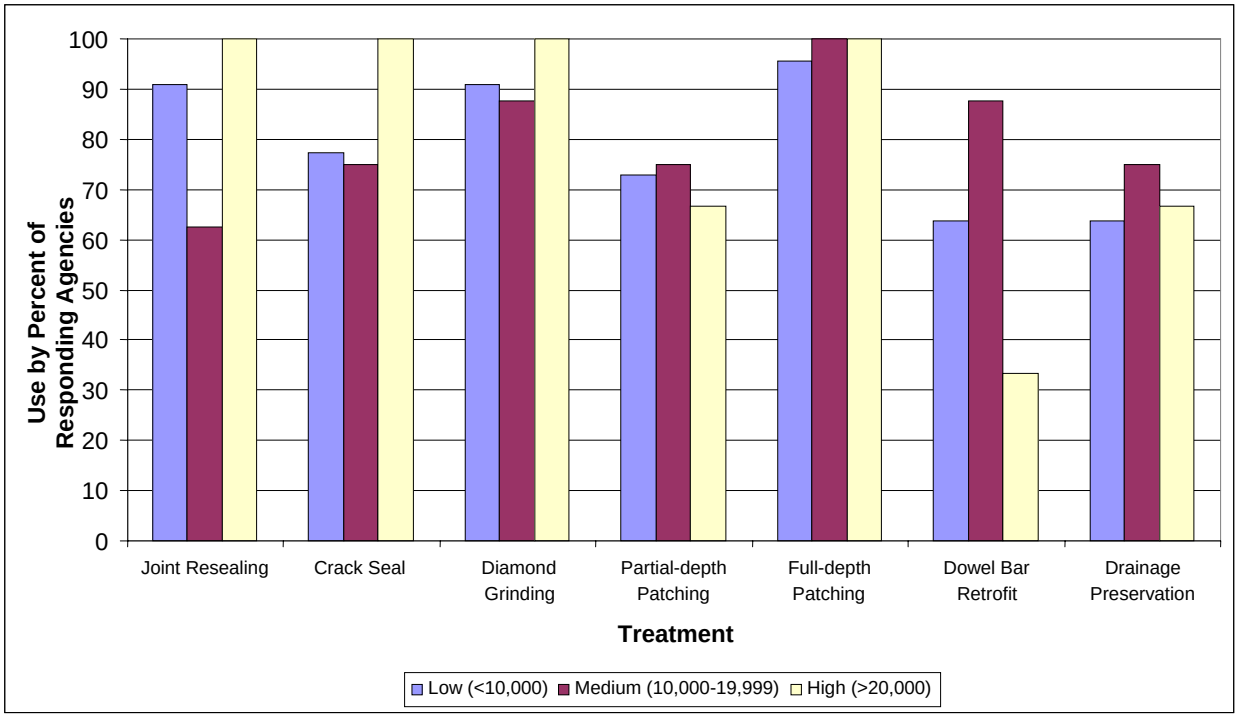

Figure 3. Percent of treatment use on rural PCC roadways for different ranges of high traffic volumes.

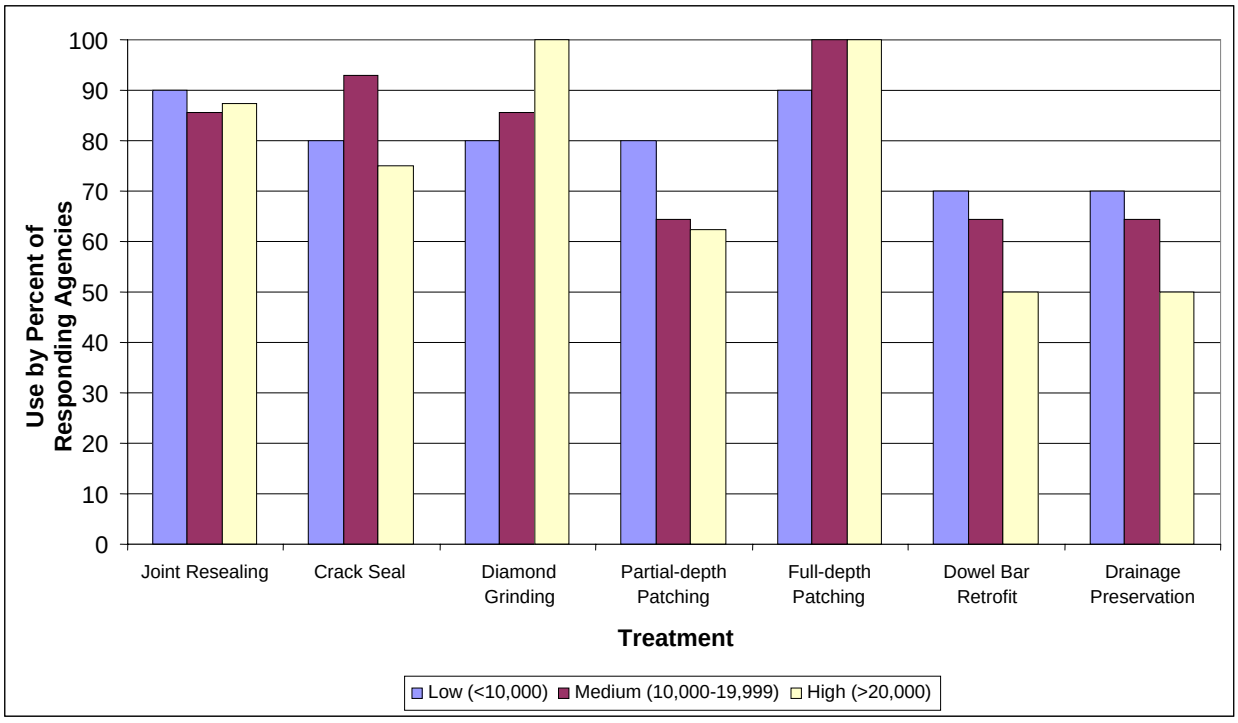

Figure 4. Percent of treatment use on urban PCC roadways for different ranges of high traffic volumes.

Input was also sought on those treatments considered not appropriate for preventive maintenance on high traffic volume roadways. As indicated in Table 4, the most commonly cited treatments that are not used are all thin surfacings. Possible explanations include the shorter life of these treatments, their reduced durability, and the higher risk associated with the failure of a thin treatment applied over a high traffic volume roadway.

Table 4
Summary of Preventive Maintenance Treatments Considered by Respondents To Be Not Applicable For PCC Rural and Urban Roadways

Treatments Identified Not Applicable for High Traffic Volume PCC Pavements	Percent of Respondents Rural / Urban
Thin PCC overlays	62 / 55
Thin bonded wearing course (e.g., HMA < 1 in.)	75 / 73
Thin HMA overlays (< 1.5 in.)	62 / 55

The primary reasons cited for not using treatments included lack of agency experience, a bias against the treatment, treatment cost, and the durability/expected life of the treatment. Previous treatment failures were also given as an explanation.

Another important consideration is the available construction time associated with placing treatments on high traffic volume roadways. It is expected that the higher the traffic volumes, the less likely it is that an agency will be able (or be willing) to consider longer closures. A typical scheme for distinguishing among closure times is to divide them into single shift or overnight closures (these are typically 6 to 8 hours long), weekend closures (for example, from Friday evening after rush hour until Monday morning at the start of the next rush hour), and longer closures. As shown in Table 5, in response to the question “Under which of the following available closure time scenarios you consider using the listed treatments on urban roadways?” almost all of the treatments were identified as being able to be placed with even the shortest (overnight or single shift) closure; only thin PCC overlays were identified as more appropriate for longer closures. These results suggest that closure times are not a barrier to the use of preservation treatments on high traffic volume PCC roadways.

Another factor covered in the survey is the type of contracts used to ensure quality for preservation treatments on high traffic volume roadways. Survey responses are summarized in Table 6, and indicate that most agencies use QC/QA procedures in the placement of these treatments, followed by contract maintenance, and performance specifications. Warranties are hardly used for the construction of any of these treatments.

Table 5
Summary of Closure Time Scenarios Considered When Using a Preventive Maintenance Treatment for Urban High Traffic Volume PCC Roads

PCC Pavement Treatments for High Traffic Volume Roadways	Percent of Respondents		
	Overnight *or* Single Shift	Weekend	Longer
Concrete joint resealing	92	30	12
Concrete crack sealing	92	32	15
Diamond grinding	95	36	13
Diamond grooving	91	30	4
Partial-depth concrete pavement patching	68	49	30
Full-depth concrete pavement patching	67	50	38
Dowel bar retrofit (load-transfer restoration)	65	44	44
Thin PCC overlays	39	30	57
Thin bonded wearing course (e.g., HMA < 1 in.)	87	26	4
Thin HMA overlay (< 1.5 in.)	88	20	8
Drainage preservation	93	30	19

Note: Overnight (e.g., from 10 p.m. to 6 a.m.); Single Shift (e.g., 9 a.m. to 4 p.m.); Weekend (e.g., from 8 p.m. Friday to Monday at 5 a.m.); Longer (Longer than 2 Days)

Table 6
Summary of Contracting Mechanisms Used to Ensure Quality for a Preventive Maintenance Treatment for High Traffic Volume PCC Roads

PCC Pavement Treatments for High Traffic Volume Roadways	Contracting Mechanisms Used			
	QC/QA	Performance Specifications	Warranties	Contract Maintenance
Concrete joint resealing	56	31	6	39
Concrete crack sealing	56	31	6	42
Diamond grinding	59	38	6	35
Diamond grooving	55	40	5	30
Partial-depth concrete pavement patching	59	22	6	44
Full-depth concrete pavement patching	58	29	8	39
Dowel bar retrofit (load-transfer restoration)	58	32	6	35
Thin PCC overlays	56	38	0	38
Thin bonded wearing course (e.g., HMA < 1 in.)	72	33	6	33
Thin HMA overlay (< 1.5 in.)	75	35	5	40
Drainage Preservation	75	20	5	45

SUMMARY AND CONCLUSIONS

Phase I of this study was intended to assess the state of the practice regarding pavement preservation practices for high traffic volume roadways, identify successful techniques that are not yet fully deployed, and outline challenges to the implementation of pavement preservation. As has been shown with the previously presented results, almost all of the treatments used on PCC pavements can be successfully used on high traffic volume roadways. Even treatments that are not widely used (by greater than 70 percent of respondents) are consistently used by over 50 percent of the respondents. The treatments that are not consistently used have in common that they are thin surfacings, and among the stated reasons for not using these treatments are a lack of experience and the durability/expected life of the treatment.

Those agencies that were not using pavement preservation or preservation strategies were also asked what additional guidance they needed. Over 50 percent said that they needed significant guidance on treatment durability/expected life, and over 40 percent cited information on appropriate climatic regions for treatments and applicable traffic volumes. Some guidance was identified as needed on many factors, including the following:

- Other agency experience.
- Typical noise associated with treatment.
- Treatment production rate.
- Treatment costs by region.
- Obtaining experienced contractors.
- Material availability.
- Opening to traffic.

In addition to further refinement of the Phase I results, the purpose of the second phase of this project is to develop guidelines for using pavement preservation on high traffic volume roadways. It is clear that the guidance for PCC pavements needs to specifically address the state of the practice that has made the common treatments widely used on roadways carrying all levels of traffic. Furthermore, providing information on the following factors should help to increase the use and performance of such treatments:

- Durability.
- Expected life.
- Material selection.
- Guidelines for opening to traffic.
- Noise (where appropriate).
- Costs.

In addition to considering the above factors, subsequent work in Phase II will include developing general guidance on the following aspects of treatment selection:

- Pavement condition.
- Climate/environment.

- Traffic volume.
- Available work hours.

Treatment selection tools will also be developed in phase II to help agencies make better decisions regarding the use of PCC pavement preservation on high traffic volume roadways.

REFERENCE

Caltrans. Maintenance *Technical Advisory Guide, Volume II—Rigid Pavement Preservation.* Second Edition. 2008. California Department of Transportation, Sacramento.