Preservation of High Volume Concrete Pavements

ACPA

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SHRP 2 REPORT S2-R26-RR-2

Guidelines for the Preservation of High-Traffic-Volume Roadways

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Rural
5,000 vpd

Urban
10,000 vpd

Treatment Use on High-Traffic Volume Rural and Ur

Treatment	Treatment Usage	
	Rural (ADT >5,000 vpd)	Urban (ADT >10,000 vpd)
Concrete joint sealing	**Extensive**	**Extensive**
Concrete crack sealing	**Extensive**	**Extensive**
Diamond grinding	**Extensive**	**Extensive**
Diamond grooving	Moderate	**Extensive**
Partial-depth concrete patching	**Extensive**	Moderate
Full-depth concrete patching	**Extensive**	**Extensive**
Dowel bar retrofitting (i.e., load transfer restoration)	Moderate	Moderate
Ultra-thin bonded wearing course	Limited	Moderate
Thin HMA overlay	Limited	Moderate

Note: Extensive = Use by ≥66% of respondents; Moderate = 33% to 66% usage; Limited = <33% usage.

Treatment Use During Different Closure Conditions

	Rural			Urban		
Treatment	Overnight or Single Shift	Weekend	Longer	Overnight or Single Shift	Weekend	Longer
Concrete joint resealing	**Extensive**	Limited	Limited	**Extensive**	Limited	Limited
Concrete crack sealing	**Extensive**	Limited	Limited	**Extensive**	Limited	Limited
Diamond grinding	**Extensive**	Limited	Limited	**Extensive**	Limited	Limited
Diamond grooving	**Extensive**	Limited	Limited	**Extensive**	Limited	Limited
Partial-depth concrete patching	**Extensive**	Moderate	Moderate	**Extensive**	Moderate	Limited
Full-depth concrete patching	**Extensive**	Moderate	Moderate	Moderate	Moderate	Moderate
Dowel bar retrofitting	**Extensive**	Moderate	Moderate	Moderate	Moderate	Moderate
Ultra-thin bonded wearing course	**Extensive**	Limited	Limited	**Extensive**	Limited	Limited
Thin HMA overlay	**Extensive**	Limited	Limited	**Extensive**	Limited	Limited

Note: Extensive = Use by ≥66% of respondents; Moderate = 33% to 66% usage; Limited = <33% usage.

Treatment Costs

Treatment	Relative Cost ($ to $$$$)	Estimated Unit Cost
Joint resealing	$	$1.00 to $2.50/ft
Crack sealing	$	$0.75 to $2.00/ft
Diamond grinding	$$	$1.75 to $5.50/yd²
Diamond grooving	$$	$1.25 to $3.00/yd²
Partial-depth patching	$$/$$$	$75 to $150/yd² (patched area) (equivalent $2.25 to $4.50/yd², based on 3% surface area patched)
Full-depth patching	$$/$$$	$75 to $150/yd² (patched area) (equivalent $2.25 to $4.50/yd², based on 3% surface area patched)
Dowel bar retrofitting	$$$	$25 to $35/bar (equivalent $3.75 to $5.25/yd², based on 6 bars per 12-ft crack/joint and crack/joint retrofits every 30 ft)
Ultra-thin bonded wearing course	$$$	$4.00 to $6.00/yd²
Thin HMA overlay	$$$	$3.00 to $6.00/yd²

Note: $ = low cost; $$ = moderate cost; $$$ = high cost; $$$$ = very high cost.

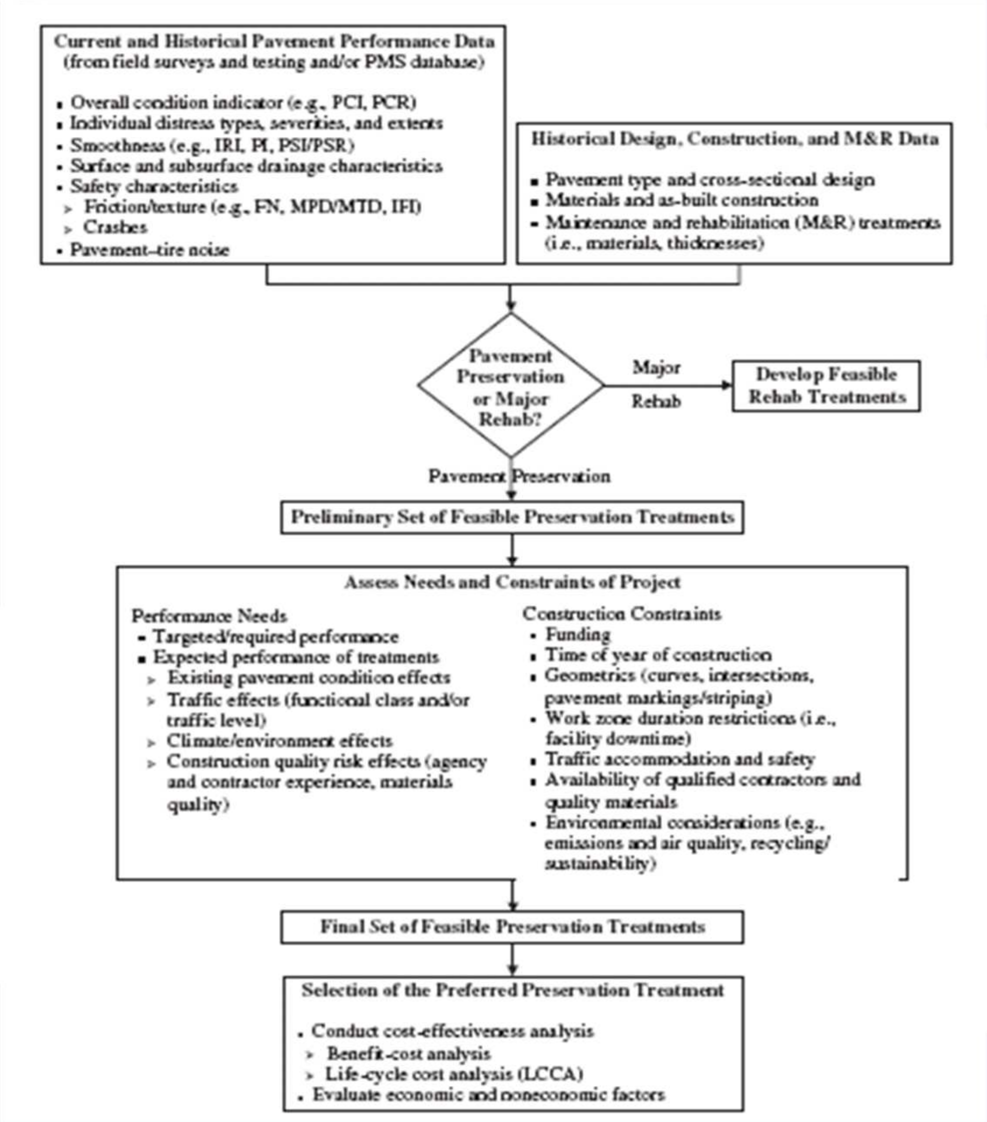
Traditional Concrete Pavement Preservation

Treatment	Expected Performance: Treatment Life (yr)	Expected Performance: Pavement Life Extension (yr)
Concrete joint resealing	2–8	5–6
Concrete crack sealing	4–7	NA
Diamond grinding	8–15	NA
Diamond grooving	10–15	NA
Partial-depth concrete patching	5–15	NA
Full-depth concrete patching	5–15	NA
Dowel bar retrofitting	10–15	NA
Ultra-thin bonded wearing course	6–10	NA
Thin HMA overlay	6–10	NA

Sources: Peshkin et al. 1999; Smith et al. 2008; Peshkin et al. 2007; Caltrans 2008; NDOR 2002.
Note: NA = Not available.

Part2

Sequential Approach for Evaluating and Selecting Strategies



Feasibility Matrix for Candidate Treatments (Preliminary)

Preservation Treatment	Window of Opportunity		Distress Types and Severity Levels (L = Low, M = Medium, H = High)				
			Surface Distress				
	PCI/ PCR	Age (yr)	Polish	Map Crack/Scale (Non-ASR)	D-Crack	Popouts	Water Bleed/Pump
			—	—	L/M/H	—	—
Concrete joint resealing	75–90	5–10					
Concrete crack sealing	70–90	5–12					
Diamond grinding	70–90	5–12	●	⊙	× × ×	×	×
Diamond grooving	70–90	5–12	○	×	× × ×	×	×
Partial-depth concrete patching	65–85	6–15	×	○	× × ×	⊙	×
Full-depth concrete patching	65–85	6–15	×	○	○⊙●[b]	×	⊙
Dowel bar retrofitting	65–85	6–15	×	×	× × ×	×	⊙
Ultra-thin bonded wearing course	70–90	5–12	⊙	●	⊙○×	○	×
Thin HMA overlay	70–90	5–12	⊙	●	⊙○×	○	×

Note: ● = Highly Recommended; ⊙ = Generally Recommended; ○ = Provisionally Recommended; × = Not Recommended.
[a] May be appropriate in conjunction with partial- and/or full-depth repairs to ensure smooth profile.
[b] Isolated incidences of D-cracking only.
[c] Isolated incidences of faulting only.
[d] Likely needed in conjunction with diamond grinding.

Feasibility Matrix for Candidate Treatments (Continued)

	Distress Types and Severity Levels						Surface Characteristics Issues		
	Joint Distress		Cracking Distress		Deformation Distress				
	Joint Seal Damage	Joint Spall	Corner	Long/ Trans	Faulting	Patches	Ride Quality	Friction	Noise
Preservation Treatment	L/M/H	L/M/H	L/M/H	L/M/H	L/M/H	L/M/H	—	—	—
Concrete joint resealing	○⊙●	○××							
Concrete crack sealing			●⊙○	●⊙○					
Diamond grinding	×××	×××	×××	××○[a]	⊙●⊙	⊙●⊙	●	⊙	●
Diamond grooving	×××	×××	×××	×××	×××	×××	×	⊙	●
Partial-depth concrete patching	×××	⊙●●	×××	×○⊙	×××	○⊙○	×	×	×
Full-depth concrete patching	×××	×○⊙	⊙●●	××○	×○⊙[c]	○⊙●	⊙	×	×
Dowel bar retrofitting	×××	×××	×○○	×××	○⊙●[d]	×××	×	×	×
Ultra-thin bonded wearing course	×××	×××	○××	○⊙○	⊙○×	⊙●⊙	●	●	⊙
Thin HMA overlay	×××	×××	○××	○⊙○	⊙○×	⊙●⊙	●	●	●

Feasibility Matrix for Final Identification

Preservation Treatment	Treatment Durability: Rural Roads: High Traffic ADT >5,000 vpd	Rural Roads: Climatic Zone: Deep Freeze	Rural Roads: Climatic Zone: Moderate Freeze	Rural Roads: Climatic Zone: Nonfreeze	Urban Roads: High Traffic ADT >10,000 vpd	Urban Roads: Climatic Zone: Deep Freeze	Urban Roads: Climatic Zone: Moderate Freeze	Urban Roads: Climatic Zone: Nonfreeze	Work Zone Duration Restrictions: Overnight or Single Shift	Work Zone Duration Restrictions: Weekend	Work Zone Duration Restrictions: Longer	Expected Performance on High-Volume Facility (yr)	Relative Cost
Concrete joint resealing	●	⊙	●	●	●	●	●	●	●			4–7	$
Concrete crack sealing	●	⊙	●	●	●	⊙	●	●	●			4–6	$
Diamond grinding	●	⊙	●	●	●	⊙	●	●	●			6–12	$$
Diamond grooving	⊙	×	⊙	×	●	×	⊙	⊙	●			6–12	$$
Partial-depth patching	●	●	●	●	⊙	⊙	●	●	●[a]	●[a]	●	5–15	$$/$$$
Full-depth patching	●	●	●	●	●	●	●	●	●[a]	●[a]	●	10–15	$$/$$$
Dowel bar retrofitting	⊙	●	●	●	⊙	⊙	⊙	●	●[a]	●[a]	●	10–15	$$$
Ultra-thin bonded wearing course	○	⊙	⊙	×	⊙	×	⊙	⊙	●			5–7	$$$
Thin HMA overlay	○	×	●	×	⊙	×	⊙	⊙	●			5–8	$$$

Note: ● = Highly Recommended; ⊙ = Generally Recommended; ○ = Provisionally Recommended; × = Not Recommended.
$ (lowest relative cost) ↔ $$$$ (highest relative cost).
[a] Use of high early strength or fast-track proprietary materials make these treatments suitable options for overnight, single-shift, and weekend closures. Use of conventional PCC repair materials generally requires "longer" closures.

Example Preservation Decision Matrix

Attribute and Selection Factor	Attribute Weight	Factor Weight	Combined Weight	Treatment 1		Treatment 2	
				Rating Score	Weighted Score	Rating Score	Weighted Score
Economic	40						
Initial cost		30	12.0				
Cost-effectiveness		30	12.0				
Agency cost		10	4.0				
User cost		30	12.0				
Total		100					
Construction/materials	25						
Availability of qualified contractors		20	5.0				
Availability of quality materials		20	5.0				
Conservation of materials/energy		30	7.5				
Weather limitations		30	7.5				
Total		100					
Customer satisfaction	25						
Traffic disruption		40	10.0				
Safety issues		40	10.0				
Ride quality and noise issues		20	5.0				
Total		100					
Agency policy/preference	10						
Continuity of adjacent pavements		20	2.0				
Continuity of adjacent lanes		20	2.0				
Local preference		60	6.0				
Total		100					
			Cumulative Weighted Score				

Part 2 PMS Trigger Values

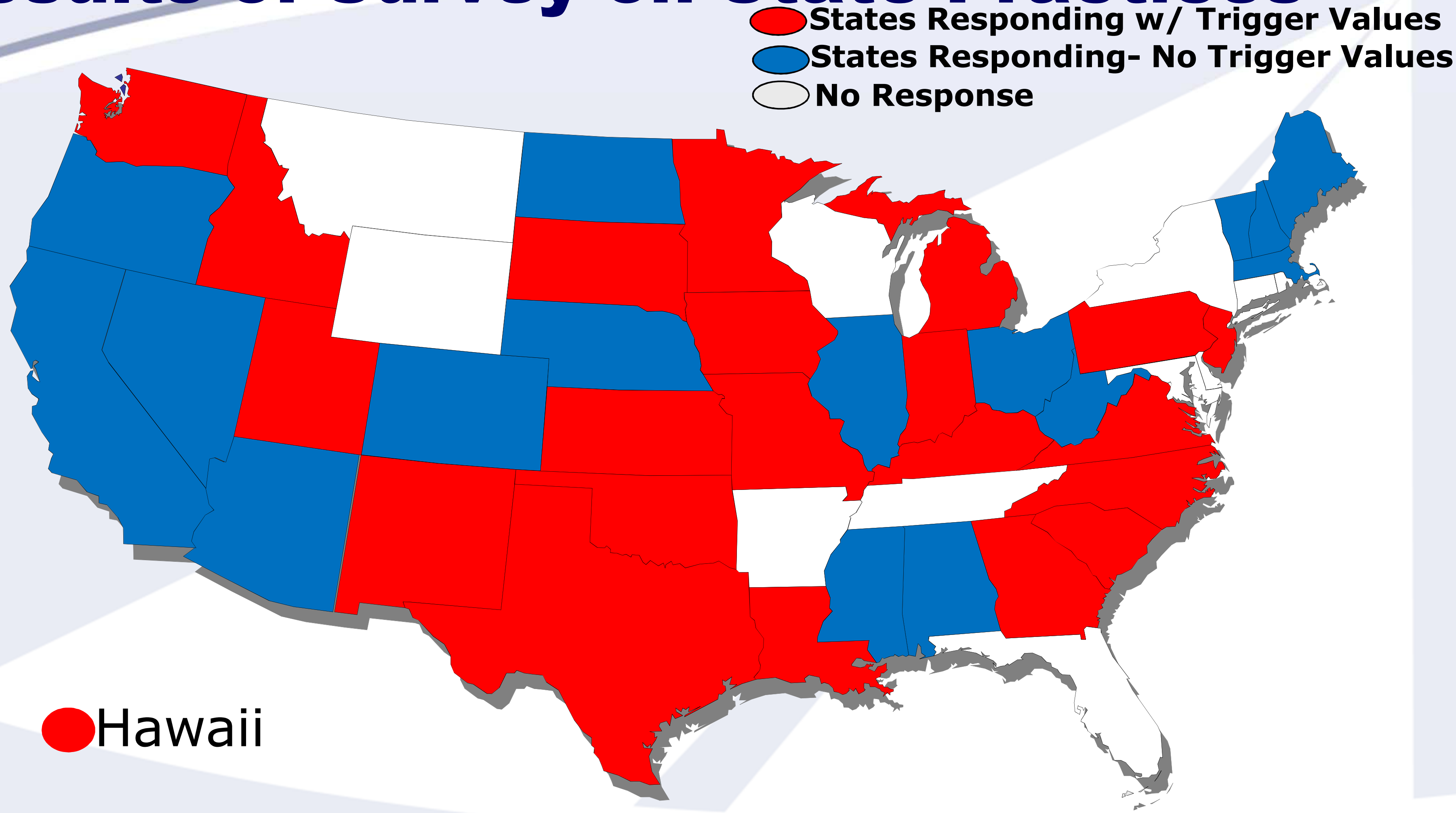
Purpose of Survey

- Establish Estimate of Percent of Concrete Pavement in Each Network
- Establish State-of-the-Practice in States' Management of Concrete Pavements
- Review Distress Data Collection Procedures of Agencies
- Identify Opportunities to Improve Practice
  - Connection of Design to PMS (Closed Loop)

Survey Approach

- FHWA Provided Data Base of State PMS Contacts
- Email Survey to the State Contacts
- Follow Up Emails for non-responding states
- Lose a Couple Surveys Here and There
- Prepare Draft Report
- Transmit Report to States & Full ETG for Comment
- Finalize Report

Results of Survey on State Practices



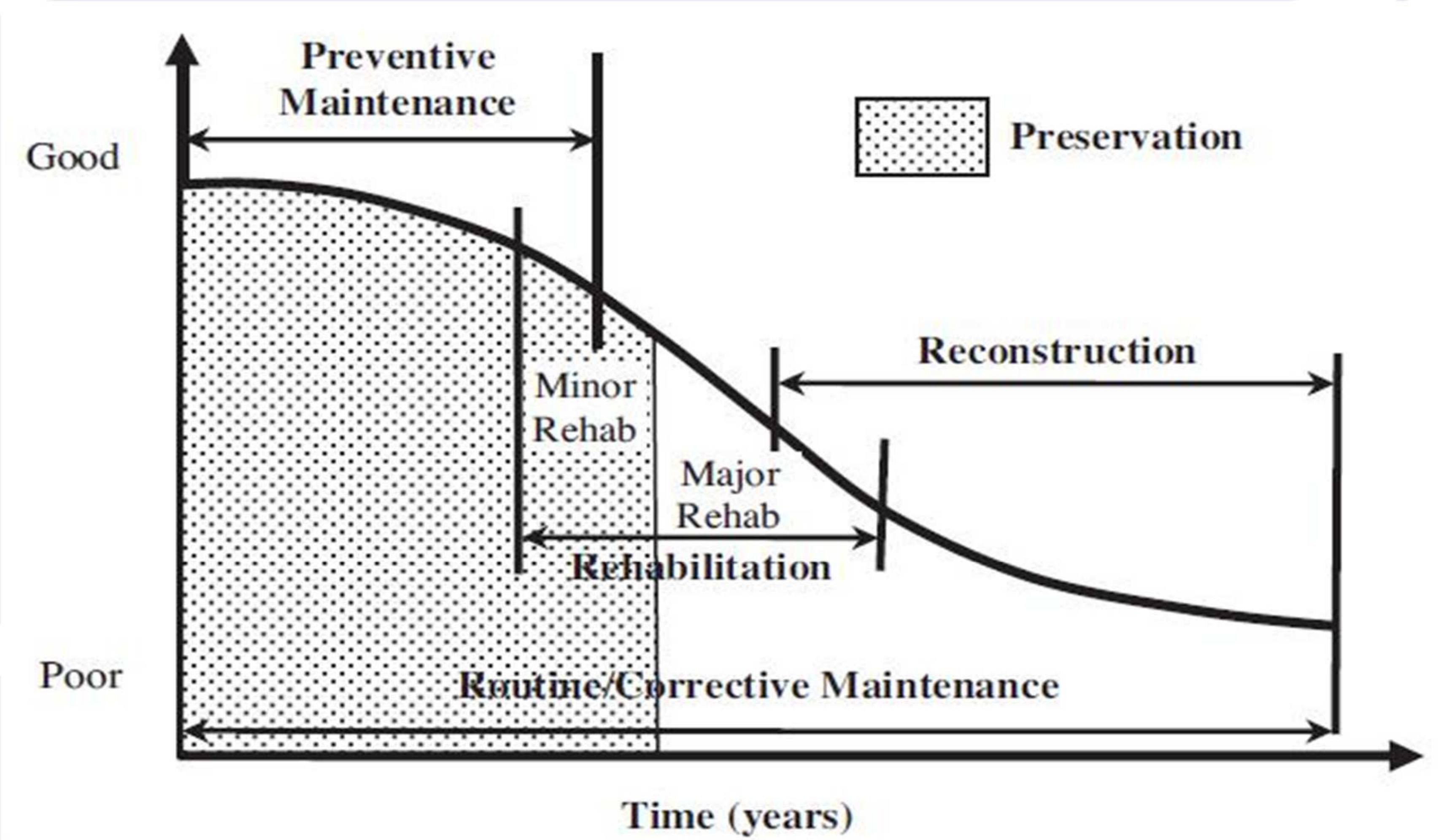
Potential Follow Up Activities

- Develop Best Practices Reports from Selected States
- Research What Parameters Should be Used to Manage Concrete Pavement Preservation
- Establish Life Extension of Each Concrete Preservation Treatment
- Engage TSP2 Partnerships in Identifying Opportunities and Solutions
- FHWA Facilitate State Showcases at TSP2
- NC2 Presentation
- Compare Survey Results to FHWA Pavement Preservation State Appraisals and FHWA PMS Research Review
- Compare State/Federal PMS Curves to LTPP Concrete Performance Curves
- Develop Procedures for Accounting for Strategy Cost Increases Over Time
- Provide Update to FHWA PMS Database
- What to Do With Final Report?

Part 3 –Expected Pavement Life Extension

Treatment Life Versus Pavement Extension Life

Traditional Pavement Management



Traditional Concrete Pavement Preservation

Treatment	Expected Performance: Treatment Life (yr)	Expected Performance: Pavement Life Extension (yr)
Concrete joint resealing	2–8	5–6
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Diamond grinding	8–15	14 - 17
Diamond grooving	10–15	NA
Partial-depth concrete patching	5–15	NA
Full-depth concrete patching	5–15	NA
Dowel bar retrofitting	10–15	NA
Ultra-thin bonded wearing course	6–10	NA
Thin HMA overlay	6–10	NA

?

Sources: Peshkin et al. 1999; Smith et al. 2008; Peshkin et al. 2007; Caltrans 2008; NDOR 2002.

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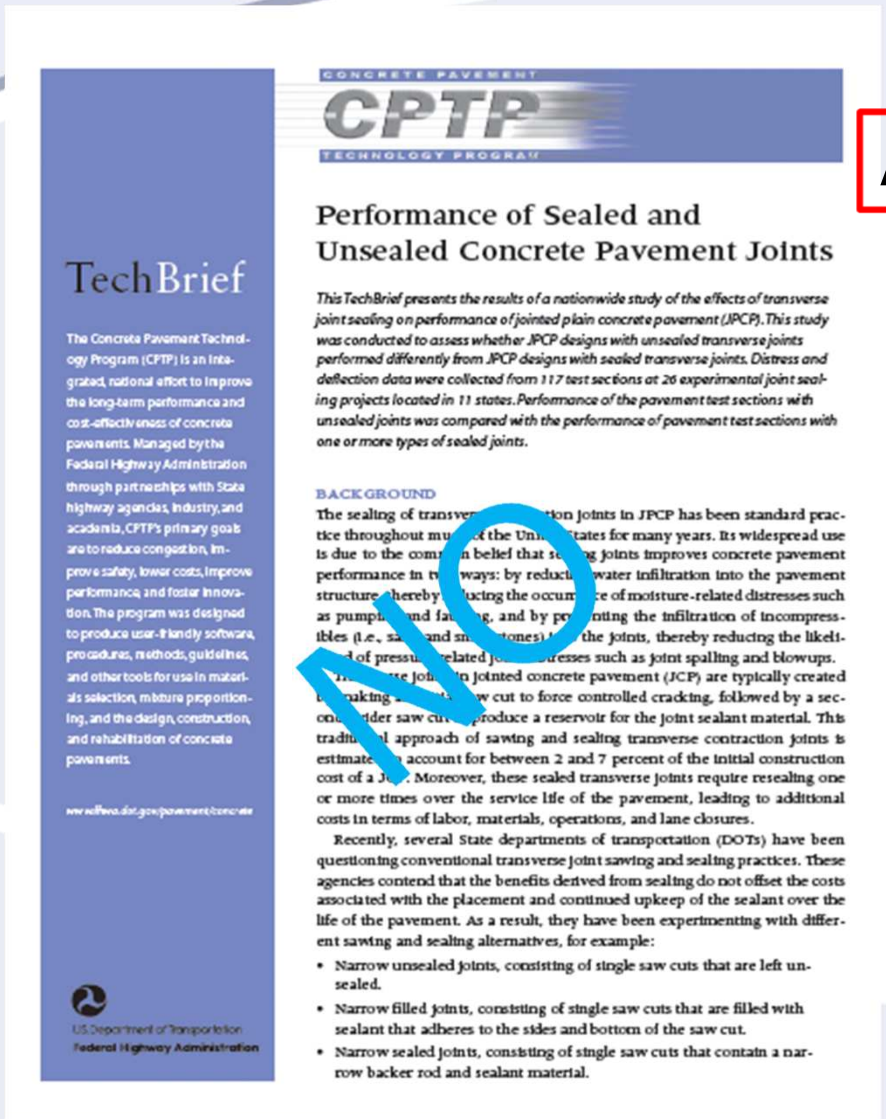
Is Joint Sealant Cost Effective?

FHWA Sealant Effectiveness Study



CONCRETE PAVEMENT

CPTP

TECHNOLOGY PROGRAM

TechBrief

The Concrete Pavement Technology Program (CPTP) is an integrated, national effort to improve the long-term performance and cost-effectiveness of concrete pavements. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, CPTP's primary goals are to reduce congestion, improve safety, lower costs, improve performance, and foster innovation. The program was designed to produce user-friendly software, procedures, methods, guidelines, and other tools for use in materials selection, mixture proportioning, and the design, construction, and rehabilitation of concrete pavements.

www.fhwa.dot.gov/pavement/concrete

U.S. Department of Transportation
Federal Highway Administration

Performance of Sealed and Unsealed Concrete Pavement Joints

This TechBrief presents the results of a nationwide study of the effects of transverse joint sealing on performance of jointed plain concrete pavement (JPCP). This study was conducted to assess whether JPCP designs with unsealed transverse joints performed differently from JPCP designs with sealed transverse joints. Distress and deflection data were collected from 117 test sections at 26 experimental joint sealing projects located in 11 states. Performance of the pavement test sections with unsealed joints was compared with the performance of pavement test sections with one or more types of sealed joints.

BACKGROUND

The sealing of transver[illegible]tion joints in JPCP has been standard practice throughout mu[illegible] the Uni[illegible] States for many years. Its widespread use is due to the com[illegible]n belief that se[illegible]g joints improves concrete pavement performance in t[illegible] ways: by reducti[illegible] water infiltration into the pavement structure, thereby [illegible]ucing the occurr[illegible]ce of moisture-related distresses such as pump[illegible]nd fa[illegible]g, and by pr[illegible]nting the infiltration of incompressibles (i.e., sa[illegible] and s[illegible]tones) [illegible] the joints, thereby reducing the likeli[illegible]d of pressu[illegible]related jo[illegible]resses such as joint spalling and blowups.

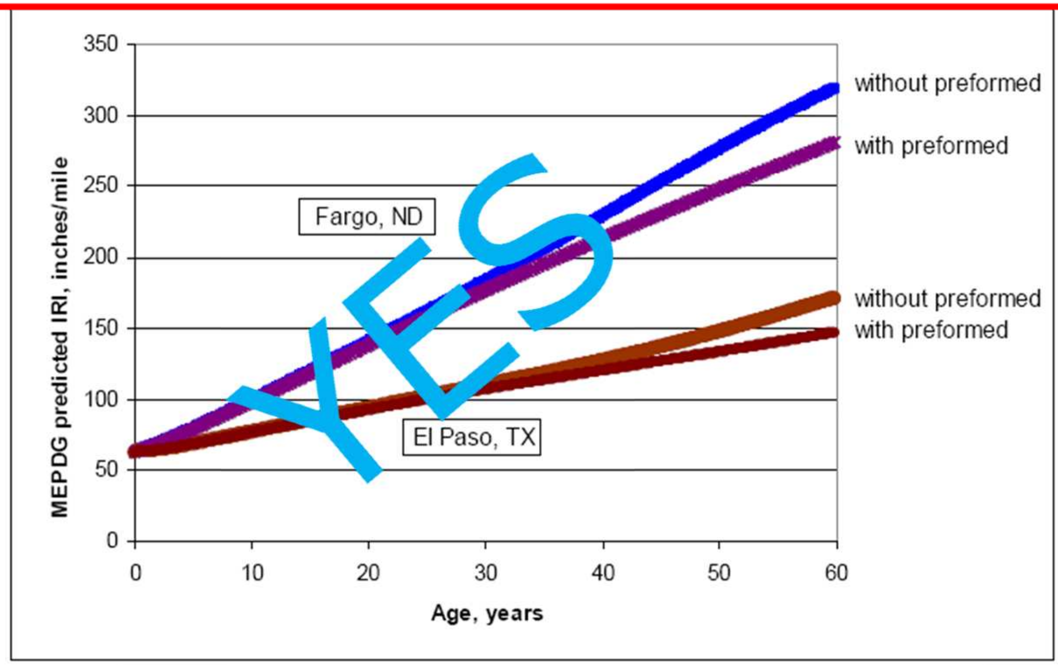
[illegible] joi[illegible]n jointed concrete pavement (JCP) are typically created [illegible]making [illegible]w cut to force controlled cracking, followed by a seco[illegible]ider saw cu[illegible]produce a reservoir for the joint sealant material. This tradi[illegible]l approach of sawing and sealing transverse contraction joints is estimate[illegible] account for between 2 and 7 percent of the initial construction cost of a J[illegible]. Moreover, these sealed transverse joints require resealing one or more times over the service life of the pavement, leading to additional costs in terms of labor, materials, operations, and lane closures.

Recently, several State departments of transportation (DOTs) have been questioning conventional transverse joint sawing and sealing practices. These agencies contend that the benefits derived from sealing do not offset the costs associated with the placement and continued upkeep of the sealant over the life of the pavement. As a result, they have been experimenting with different sawing and sealing alternatives, for example:

- Narrow unsealed joints, consisting of single saw cuts that are left unsealed.
- Narrow filled joints, consisting of single saw cuts that are filled with sealant that adheres to the sides and bottom of the saw cut.
- Narrow sealed joints, consisting of single saw cuts that contain a narrow backer rod and sealant material.

NO

AASHTO New Design Guide



Preservation

Repair

Traditional Approach

Questions?