Tech Brief

U.S. Department of Transportation
Federal Highway Administration

PAVEMENT PRESERVATION HOW

The fourth round of Every Day Counts (EDC-4) innovations promoted quality construction and materials practices that apply to both flexible and rigid pavements. For flexible pavements, these include using improved specifications for thin asphalt surfacings such as chip seals, scrub seals, slurry seals, micro surfacing, and ultrathin bonded wearing courses; following improved construction practices; and using the right equipment to place these treatments. Rigid pavement treatments include the rapid retrofitting of dowel bars to reduce future faulting; the use of new, fast-setting partial- and full-depth patching materials to create a long-lasting surface; advanced pavement removal techniques to accelerate patching construction times; and advancements in diamond grinding that contribute to smoother and quieter pavement surfaces with enhanced friction.

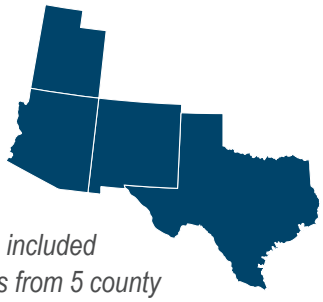
BACKGROUND

Regional peer-to-peer exchanges between states were initiated to exchange knowledge on "How" to effectively implement pavement preservation. Adoption of a comprehensive pavement preservation program will ultimately result in an improved pavement condition and safety rating for the overall network, reduced agency and user delay costs, and decreased environmental impact. In order to achieve these objectives, an understanding of the concepts, capabilities, and applications relevant to constructing pavement preservation treatments with quality materials must be implemented via a technology program aimed at transportation agencies, contractors, consultants, and Federal Highway Administration (FHWA) staff.

PAVEMENT PRESERVATION HOW: ARIZONA, TEXAS, UTAH, AND NEW MEXICO

EDC-4 PEER-TO-PEER EXCHANGES

INTRODUCTION



On May 2nd and 3rd, 2019, an FHWA-sponsored EDC-4 "How" Pavement Preservation State Peer-to-Peer Exchange was conducted in Phoenix, Arizona. State department of transportation (DOT) participants included 28 DOT representatives from Arizona, 1 from Texas, 2 from Utah, and 1 from New Mexico. Additional participants included 4 FHWA representatives, 1 consultant, and representatives from 5 county governments, 24 municipalities, and 9 tribal communities. Larry Galehouse with the National Center for Pavement Preservation and Larry Scofield with the International Grooving & Grinding Association and American Concrete Pavement Association facilitated the day-and-a-half-long meeting. Arizona was the host state and provided meeting room facilities. Antonio Nieves of the FHWA introduced the meeting background and kicked off the meeting.

The meeting format consisted of each of the states identifying their current procedures, issues, and successes for each of the topics discussed. Table 1 indicates the discussion topics.

Upon conclusion of the peer-to-peer exchange meeting, the participants had the opportunity to tour the Chandler, Arizona, manufacturing facility of Crafco, Inc., a leading supplier of pavement preservation products.

Table 1. List of pavement preservation treatments discussed

Asphalt pavement preservation treatments	Concrete pavement preservation treatments
Chip seal	Partial-depth repair
Micro surfacing and slurry seal	Precast slabs
Cold and hot in-place recycling	Diamond grinding
Crack seal	—
Ultrathin bonded wearing course	—
Scrub seal	—
Cape seal	—

SUMMARY OF IMPORTANT ISSUES OR SUCCESSES

Asphalt Concrete Pavement Preservation

Chip sealing: Two states place chip seals on a six- to seven-year cycle. They principally use emulsion-based chip seals. One state, which is one of the largest users of chip seal technology in the country, mainly uses hot-applied binder with precoated chips and an annual chip seal program budget of $280 to $300 million. One state uses in-house personnel for chip seal placements, and each of that state's districts has its own equipment and trained crews. Some of these districts use 100% recycled asphalt pavement (RAP) chip seals.

All four state agencies try to do roadway preparation work 6 to 12 months in advance if possible, particularly crack sealing and patching. If the construction project includes crack sealing, in some instances there may be a contractual delay before chip sealing begins.

A moratorium on chip seal placement was recently initiated in one state. That state partnered with industry to develop new specifications that require test section construction and approval prior to advancing the chip seal process. The state now also requires training for both contractor and agency personnel prior to construction.

One state does not raise the reduced construction speed limit until after the fog seal has been placed, which is typically after seven days.

Some local agencies have rebranded chip seals as fractured aggregate surface treatments (FAST) and have developed one specification for high-volume roadways and another for low-volume roadways.

For a summary of chip seal use, see Table 2.

Micro surfacing and slurry sealing: While two states seldom use these treatments, two states use them frequently. Micro surfacing is the major preservation treatment used on Interstates in the two states where the treatment is used frequently. These states prefer micro surfacing over slurry seals. One of the advantages of micro surfacing is that it can be placed at night, whereas a chip seal cannot. While specifications have typically focused on methods, one state attempted a warranty specification, but warranties could not be successfully administered and were discontinued. All four states use contractor-applied micro surfacing. Placement of micro surfacing over open-graded friction courses is not allowed in one state. Local agencies primarily tend to use slurry seals instead of micro surfacing. They use Type III slurry on high-volume roads and Type II slurry on others. Latex-modified emulsions are preferred by some local agencies for slurry. See Tables 3 and 4.

Table 2. Chip sealing

State	Design		Material type				Construction procedures						
	Design procedure	Maximum ADT	Aggregate	Binder	Top size	P200	Aggregate rate	Binder rate	Rollers	Sweeping	Fog seal	Stripe pretreatment	Pilot vehicle
Arizona	NA	40,000	See table in Section 404-2.02.C	CRS-2	⅜ and ¼ in.	NA	0.01 yd^3/ yd^2 or by mix design	0.06 gal/yd^2 or by mix design	3 pneumatic rollers	Power and hand broom	Special provision required	Broom and tack coat 0.06 gal/yd^2	Yes
New Mexico	NA	NA	NA	HFE150P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Utah	NA	None	See Table 2 in Section 02785	LMCRS-2 and CRS-2P	½ in.	NA	By unit weight; see Table 3 in Section 02785.3.5.F	Rate sufficient for 50% chip embedment before rolling and 70% embedment after rolling	Minimum 3 articulating pneumatic rollers	NA	Flush coat 0.11 ± 0.01 gal/yd^2 7 days after chip seal	7 days of curing	NA
Texas	NA	Unknown	½ and ⅜ in.	Mostly hot applied, CRS-2P for emulsions	NA	NA	NA	NA	Light pneumatic-tire rollers	Furnish rotary, self-propelled brooms	Item 315	NA	NA

Table 3. Micro surfacing

State	Design method	Material type				Construction procedures						
		Aggregate	Binder	Type	Cement	Application rate	Crack seal in advance	Tack in advance	Sweeping in advance	Test section	Number of courses	Calibration verification
Arizona	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2, rut fill scratch course, then lane width	NA
New Mexico	NA	NA	CSS-1HP	NA	NA	NA	NA	NA	NA	NA	NA	NA
Utah	Per mix design	See Gradation in Table 4 in Section 02735.2.2.B	AASHTO M 208 grade CQS-1h (cationic) emulsified asphalt	See Table 3 in Section 02735.2.1.C	Non-air entrained Type I/ II portland cement, hydrated lime	Minimum rate of 25 lb/ yd^2 (by dry aggregate)	NA (cleaning with water allowed)	NA	Yes	Yes, 500 ft long	NA	NA
Texas	Method spec	3/8 in., see Tables 1 and 2 in Section 350.2.2	CSS-1P Residual asphalt 6%–9% by dry unit wieght	NA	Hydraulic cement or hydrated lime at 0.5%–3% by dry aggregate	NA	NA (remove raised pavement marking)	CSS-1H or SS-1H at 0.04–0.10 gal/yd^2	NA	Submit sample of each aggregate, min. 1 gal asphalt emulsion, min. 1 gal mineral filler, and additives	NA	NA

Table 4. Slurry sealing

State	Design method	Material type				Construction procedures						
		Aggregate	Binder	Type	Cement	Application rate	Crack seal in advance	Tack in advance	Sweeping in advance	Test section	Number of courses	Calibration verification
Arizona	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2, rut fill scratch course, then lane width	NA
New Mexico	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Utah	Per mix design	See Gradation in Table 1 in Section 02789.2.4.A	Cationic emulsified asphalt grade CQS-1h	Asphalt slurry seal coat	Use portland cement, hydrated lime, or aluminum sulfate	18–22 lb/yd^2 by dry aggregate	NA (cleaning with water allowed)	NA	NA	NA	NA	NA
Texas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5. Cold in-place recycling

State	CIR type		Construction procedures								
	Foamed asphalt	Emulsion	Plant type		Final surface	Cement admixture	Moisture testing	Cure period before overlay	Traffic restrictions	Minimum thickness	Minimum existing AC remaining
			Central	Roadway							
Arizona	Yes	Yes	Yes	Yes	NA	Yes	NA	NA	NA	NA	2 in.
New Mexico	NA	Polymerized high-float emulsion HFE-150P or CSS-1	NA	NA	NA	Yes	Existing pavement at 1 mi intervals	2 hours	2 hours	4 in.	1–2 in.
Utah	NA	NA	NA	NA	1½ in. OL	NA	NA	NA	NA	3–4 in.	4–5 in.
Texas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 6. Hot in-place recycling

State	HIR type	Construction procedures			
		Plant type		Minimum thickness	Minimum existing AC remaining
		Central	Roadway		
Arizona	NA	NA	NA	NA	NA
New Mexico	Repaving and remixing	NA	Yes	No minimum, but 2 in. maximum	NA
Utah	NA	NA	NA	NA	NA
Texas	Surface recycling, remixing, repaving	NA	Yes	3 in.	NA

Cold in-place recycling (CIR): One state is currently the main user of this technology. Another state was an early implementer/leader in its development but then moved away from its use due to construction issues. However, that state is considering its use again with improved specifications. A third state had also previously experienced performance issues with CIR and therefore quit using it but has since developed improved specifications and is moving forward with including CIR in its toolkit. All four states require a final surface to be placed and believe it is important to have a minimum thickness of remaining existing asphalt concrete (AC). It has further been recognized that with CIR processes the material properties may change along the roadway, making modifications on the fly sometimes necessary. There was only limited use of this technology by local agencies. See Table 5.

Hot in-place recycling (HIR): All four states have successfully used this technology. One concern with its use is the extensive delay (up to three to four years) between treatment selection and actual construction. This delay can result in excess deterioration in the roadway prior to construction. One state limits its application to a maximum of the top 2 in. of pavement. Another state has only had three years of experience with the technology but has observed reflective cracking and is reconsidering the use of this technology. Local agencies have had little to no experience with this technology. See Table 6.

Crack sealing: Crack sealing is performed either as part of other maintenance activities or by contract in all four states. Hot pour is the most common sealant. None of the states route cracks before sealing; rather, they simply air-blow the cracks and use overband sealant installations. All four states seal cracks 6 to 12 months in advance of overlay placement and have all recognized the need to control overband sealant width when an overlay is to be placed. Local agencies tend to air-blow the cracks with a vacuum attachment to minimize PM10 dispersal and to clean the cracks better. One state pays for crack sealing by the lane mile. At least one state places sealant seasonally to ensure that cracks are at the widest condition when they are treated. Local agencies tend to categorize different types of crack sealant application according to ranges in crack width. For cracks wider than 3 in., mastics are used. See Table 7.

Ultrathin bonded wearing course: All four states use this treatment, with overlay thicknesses ranging from ½ to 1½ in. Two states have access to spray pavers to apply this treatment. One state uses this treatment on both AC and concrete pavements and has historically used asphalt rubber for the binder. Selecting the appropriate project on which to apply this treatment is important, as is proper preparation of the existing surface beforehand. This technology is used by local agencies with high urban traffic levels. See Table 8.

Scrub sealing: Three of the states have tried scrub seals but do not use them in practice. The fourth state does, with several districts regularly using them with CRS-2P emulsion and a ⅜ in. chip. This state also sometimes uses a scrub seal as an interlayer. Local agencies have only limited experience with the treatment.

Cape sealing: In three states, there has been little to no use of cape seals. The fourth state has not relied on this treatment in the past but placed a 40 mi long project in 2019 using a Type 3 aggregate. The state will extensively evaluate this project to verify whether the technique results in a structural improvement. Local agencies have only recently been using this option as well.

Table 7. Crack sealing

State	Sealant type			Crack preparation			Installation procedures				
	Hot pour	Mastic	Other	Route cracks	Air blow cracks	Vacuum cracks	Temperature requirements	Overband	Flush fill	Detackifier	Workforce
Arizona	Yes	Yes	Epoxy resin, ground rubber	No	Yes	Sandblasted	NA	Yes	Yes	NA	Either
New Mexico	Yes	NA	NA	Yes	Yes	NA	Ambiant air 40°F and rising, pavement 32°F	NA	No	No	NA
Utah	NA	NA	NA	No	Yes	NA	NA	Yes	No	NA	Maintenance
Texas	Yes	NA	Cold-applied	Yes	Yes	NA	Asphalt pavement: manufacturer recommendation; concrete pavement: 55°F–90°F	Yes	Yes	NA	Either in-house or by contractor

Table 8. Ultrathin bonded wearing course

State	Design method	Material type		Construction procedures				
		Aggregate type	Binder type	Crack seal in advance	Spray paver	Tack coat	Thickness	Used as interlayer
Arizona	NA	NA	NA	NA	NA	NA	NA	NA
New Mexico	NA	NA	NA	NA	Yes	NA	½–1½ in.	NA
Utah	Spec	Determine the suitability of the aggregate according to Tables 8 and 9 of Section 02787.	See Section 02745 and Special Provision 02742S	Minimum 2 weeks cure time for crack sealant	Yes	Yes	¾ in.	NA
Texas	Section 348.4.4	Coarse aggregate, fine aggregate, and filler material per Sections 348.2.1.2 and 348.2.2	Asphalt binder per Section 300, PG per Section 300.2.10, or A-R binder Type I and II per Section 300.2.9	NA	Yes, single pass	NA	½–1 in.	NA

Concrete Pavement Preservation

Partial-depth repair: One state covers its concrete with asphalt-rubber friction course (ARFC) surfaces, so it does not use partial-depth repairs. One state has only used this repair technique in a limited number of cases. The two remaining states use treatments that are similar to each other. One uses elastomeric materials due to their ease of construction and lasting performance, but the patch size is limited to 3 by 3 ft, and bulking stone is used if the patch is deeper than 2 in. The other state also primarily uses elastomeric materials but has an approved products list allowing other materials. It is recognized that this treatment is sensitive to construction and inspection methods. See Table 9.

Precast slabs: Two states use precast slabs while two do not. One state has used this treatment for ramp repair, while the other state constructed its first project using this treatment in the summer of 2019. Since precast concrete is relatively expensive, one state competitively bids cast-in-place and precast options. It is acknowledged that proper engineering is necessary to ensure that panel replacements fit properly. See Table 10.

Diamond grinding: Two states have performed a significant amount of diamond grinding with great success, one state has had limited experience with the technique due to limited amount of concrete pavement in the state, and one state does not use diamond grinding because it covers its concrete with ARFC as the final surface. Diamond grinding has generally been used to improve ride quality or noise levels or both. When using diamond grinding on existing projects for preservation, one state uses a percent improvement requirement for ride quality. One state has used Next Generation Concrete Surface, a diamond grinding noise solution, more than any other state. Local agencies do not use diamond grinding due to the lack of concrete pavements in local jurisdictions. See Table 11.

Table 9. Partial-depth repair

State	Distress type		Design		Construction practices					
	Materials-related distress	Spall repair	Repair material specs	Coring in advance	Defining patch limits	Use of milling equipment	Repair materials	Bonding agent	Grouting edges	Warranty
Arizona	No	Yes	ASTM 928	Yes	Contractor	No	APL	No	No	Yes
New Mexico	No	Yes	NA	NA	NA	NA	High early	NA	No	No
Utah	No	Yes	Fibercrete	NA	Yes	No	Type II cement	Yes	No	NA
Texas	No	Yes	NA	No	Yes	No	Rapid set or polymeric patching	Yes	No	No

Table 10. Precast slabs

State	Design				Use		Construction practices	
	Roman Stone	Illinois Tollway	Fort Miller	Caltrans	Demo project	Routinely use	Bedding type	Panels per shift
Arizona	No	No	No	No	Yes	No	Foam	12
New Mexico	NA	NA	NA	NA	Yes	No	NA	NA
Utah	NA	NA	NA	NA	NA	No	Sand	NA
Texas	NA	NA	NA	NA	Yes	No	NA	NA

Table 11. Diamond grinding

State	Purpose of grinding				Construction practices			
	Ride quality	Friction	Noise	Buried treasure	Blades per foot	Head width	Smoothness spec	Construction issues
Arizona	Yes	Yes	Yes	Yes	50–60	Minimum 3 ft	60 in./mi	No
New Mexico	Yes	Yes	Unknown	No	NA	36–48 in.	105 in./mi	NA
Utah	Yes	Yes	NA	No	NA	NA	Profilograph	NA
Texas	Yes	No	Yes	No	50–60	NA	NA	NA

KEY OBSERVATIONS

During this peer-to-peer exchange meeting, agency personnel representing four state agencies and several local agencies identified and discussed their pavement preservation successes and challenges. The state and local representatives reported the following successes and challenges.

Preservation Successes

- Recognition of the need to conduct crack sealing and patching operations 6 to 12 months in advance of surface treatment applications
- The general practice of blowing out cracks in advance of crack sealing operations and the use of dust recovery systems by local agencies to help ensure PM10 compliance in urban areas
- Competitive bidding of cast-in-place and precast full-depth slab repairs to provide lower prices
- Specification improvements that have allowed treatments that have previously been disallowed to be become part of the toolbox again
- An annual chip seal program budget in one state of $280 to $300 million
- Successful placement of RAP chip seals
- Development of fractured aggregate surface treatments (FAST) by local agencies for use in urban areas
- Successful use of elastomeric partial-depth repairs in high-traffic urban areas by limiting their size and using extender aggregate for patches over 2 in. deep or that will be subsequently diamond ground

Preservation Challenges

- Selection of the correct treatment for existing roadway conditions and prevention of additional roadway deterioration between when distress surveys are conducted and project construction
- Historical imposition of moratoriums on at least three treatments due to questionable performance, whether due to poor construction quality, improper project selection, or simply the wrong treatment applied to the wrong road
- The fact that not all treatments were included in all agencies' toolboxes at the time of the peer exchange, even though all treatments had been tried by all of the agencies at some point

SUMMARY

Eight asphalt and three concrete pavement preservation treatments were discussed in depth (see Figures 1–12). All four states use crack sealing, chip seals, and ultrathin bonded wearing courses as the predominant asphalt treatments. Diamond grinding is the predominant concrete treatment, but two states only use concrete as the final surface on a limited number of roads. The states differed among themselves and from the local agencies in terms of the desired treatment applications. Treatment application was not consistent in some cases. Proper project selection and construction quality were discussed as critical elements of successful treatments. Some treatments were recognized as more sensitive to construction practices than others, and this sensitivity has led to some of the moratoriums that have historically been imposed.

Slurry Pavers, Inc.

Figure 1. Chip sealing

VSS International

Figure 3. Slurry sealing

National Center for Pavement Preservation

Figure 2. Micro surfacing

Pavement Recycling Systems

Figure 4. Cold in-place recycling

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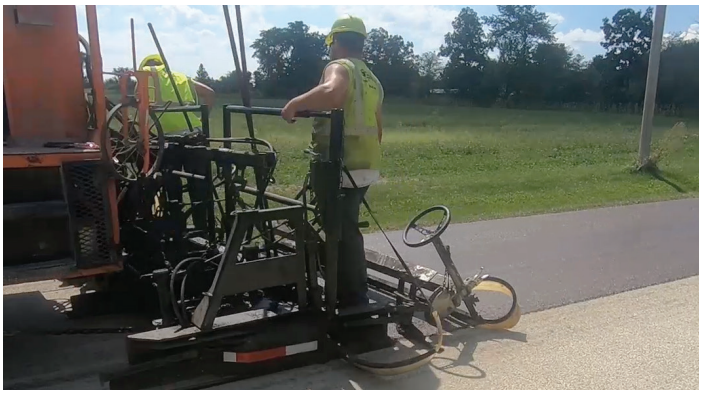
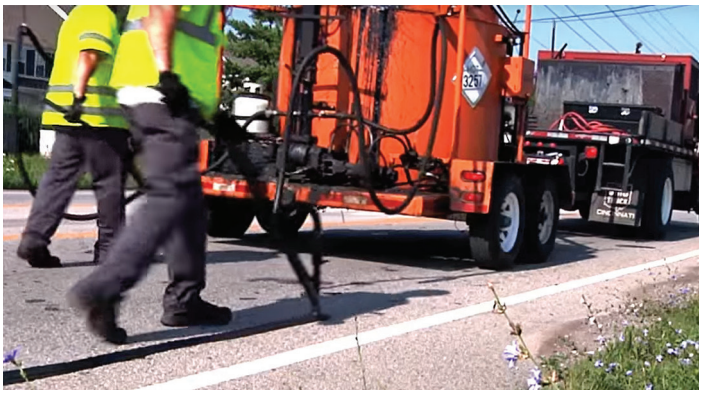
National Center for Pavement Preservation

Figure 5. Hot in-place recycling



Strawser Construction Inc.

Figure 9. Cape sealing



National Center for Pavement Preservation

Figure 6. Crack sealing

ACPA

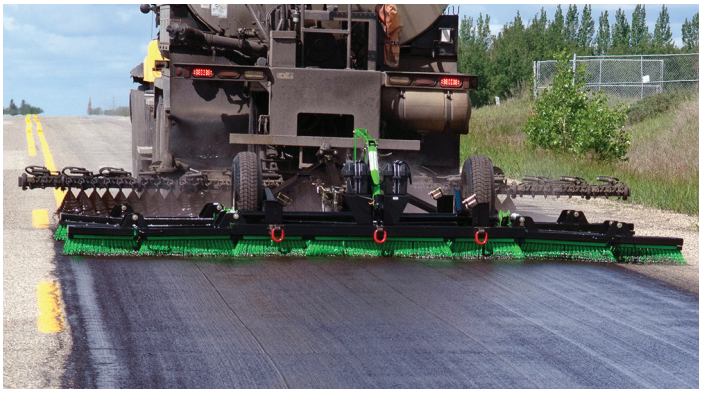
Figure 10. Partial-depth repair

All States Materials Group

Figure 7. Ultrathin bonded wearing course

Shiraz Tayabji

Figure 11. Precast slabs



Saskatchewan Ministry of Highways and Infrastructure

Figure 8. Scrub sealing

International Grooving and Grinding Association

Figure 12. Diamond grinding

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JUNE 2020
FHWA-HIF-20-007

This tech brief was developed under Federal Highway Administration (FHWA) contract DTFH61-13-D-00009.

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DISTRIBUTION AND AVAILABILITY
This tech brief can be found at https://www.fhwa.dot.gov/pavement/preservation/.

KEY WORDS
pavement, preservation, peer-to-peer

U.S. Department of Transportation
Federal Highway Administration

AGENCY SPECIFICATIONS

The relevant agency specifications are available at the following websites:

Arizona: https://azdot.gov/sites/default/files/media/2019/11/2008-standards-specifications-for-road-and-bridge-construction.pdf

Utah: https://www.udot.utah.gov/main/f?p=100:pg:885740181684789::::V,T:,302

Texas: http://www.dot.state.tx.us/business/specifications.htm

New Mexico: http://dot.state.nm.us/content/nmdot/en/Standards.html

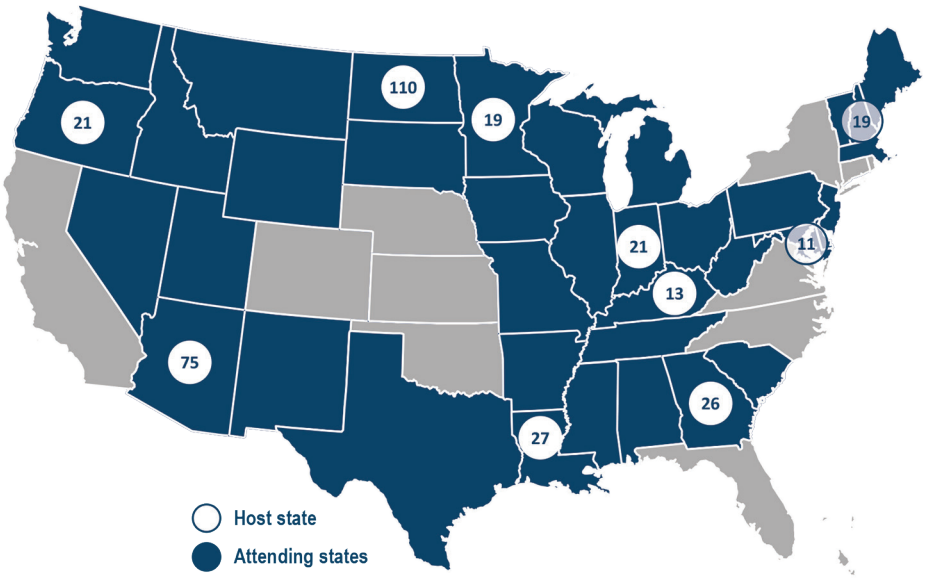
ONLINE RESOURCES

National Center for Pavement Preservation (https://www.pavementpreservation.org/)

National Concrete Pavement Technology Center (https://cptechcenter.org/)

Federal Highway Administration (https://www.fhwa.dot.gov/pavement/preservation/)

Pavement Preservation & Recycling Alliance (https://roadresource.org/)



Host state	AZ	DE	GA	IN	KY	LA	MN	NH	ND	OR
Attending states	NM	MD	AL	IL	TN	AR	IA	ME	MT	ID
	TX	NJ	SC	OH	WV	MS	MO	MA	SD	NV
	UT	PA	—	MI	—	—	WI	VT	WY	WA
Number of attendees	75	11	26	21	13	27	19	19	110	21

Regional state peer-to-peer exchanges were held in 10 states with 342 total attendees from 37 states