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: DELAWARE, MARYLAND, NEW JERSEY, AND PENNSYLVANIA

EDC-4 PEER-TO-PEER EXCHANGES

INTRODUCTION

On November 19th, 2018, an FHWA-sponsored EDC-4 "How" Pavement Preservation State Peer-to-Peer Exchange was conducted in Dover, Delaware, with one FHWA representative and six department of transportation (DOT) representatives from Delaware, one from Maryland, two from New Jersey, and two from Pennsylvania. 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. Delaware was the host state and provided meeting room facilities. Antonio Nieves of the FHWA provided 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.

Table 1. List of pavement preservation treatments discussed

Asphalt pavement preservation treatments	Concrete pavement preservation treatments
Chip seal	Partial-depth repair
Micro surfacing	Full-depth repair
Cold in-place recycling (CIR)	—
Cape seal	—
Thin bonded overlays	—
Crack seal	—
Scrub seal	—
High-friction surface treatments (HFST)	—

SUMMARY OF IMPORTANT ISSUES OR SUCCESSES

Asphalt Concrete Pavement Preservation

Chip sealing: All four states place chip seals on roadways with average daily traffic (ADT) levels ranging from 1,000 to 5,000, with two of the states only recently including the treatment in their toolkits. One state annually constructs approximately 3,000 centerline miles of chip seals.

Historically, there have been compatibility issues with emulsions, and as a result a couple states have gravitated towards hot-applied binders. It was noted that limestone aggregates exhibited more compatibility issues than granite aggregates. The states indicated that a best practice was to perform emulsion dilution at the plant.

Two states use recycled asphalt pavement (RAP) chip seals, with one of these states having 10 years of experience with RAP.

The importance of a good chip seal design process was emphasized by the state representatives. It was also noted that certain snowplow blades cause less chip seal damage during winter maintenance and certain state representatives highly recommended using them.

Training and work force attrition, especially of experienced personnel, were identified as major issues in the continued use of chip seals. See Table 2.

Micro surfacing: All four states use this treatment successfully. One state is increasing its use of slurry seals instead of micro surfacing because it reports that micro surfacing triggers certain Americans with Disabilities Act (ADA) requirements due to its thickness (see 42 U.S.C. ch. 126). That state reported that once ADA requirements are triggered, the preservation project needs to address all other ADA deficiencies, such as those pertaining to curbs and sidewalks (see 28 C.F.R. 35.151). Fog sealing in advance of placement was considered a good practice. Delamination of micro surfacing placed over pavement markings has created issues in the past when the markings were not removed prior to application. See Table 3.

Cold in-place recycling (CIR): All four states employ this treatment, but three of them only use it on a limited basis. One state has had hit-or-miss experience with CIR in terms of construction quality, while another state has had good experience with the treatment. The state with good experience has primarily found cold central plant recycling to work best but more recently has also had good experience with cold in-place recycling. A research project is currently underway at the Pennsylvania State University to look at new design methods for CIR. See Table 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
Delaware	Utah	500	Granite	NA	⅜ in.	NA	NA	NA	2–4	NA	Yes	NA	No
Maryland	NA	NA	NA	Polymer-modified emulsion	NA	NA	NA	NA	NA	NA	NA	NA	NA
New Jersey	None	Unknown	NA	Asphalt rubber	NA	0%–2%	NA	NA	NA	NA	NA	NA	NA
Pennsylvania	Modified MnDOT	5,000	Coarse aggregate: Type A, No. 8, or No. 89 on roadways with less than 1,000 ADT	Polymer-modified emulsion	Nominal ⅜ in.	0%–1%	15–25 lb/yd^2	±10% of the design rate	Minimum 2 roller passes	Power broom as needed	Yes, with blotter	NA	Yes

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
Delaware	NA	NA	NA	NA	NA	NA	NA	Yes	NA	NA	NA	NA
Maryland	NA	NA	NA	2 and 3	NA	1 coat: Type II mix: 16 ± 2 lb/yd^2; Type III mix: 22 ± 2 lb/yd^2 2 coats: Type II mix: 32 ± 2 lb/yd^2; Type III Mix: 36 ± 2 lb/yd^2	Yes, if >⅜ in.	0.05–0.1 gal/yd^2	NA	Yes	NA	Yes
New Jersey	Mix design by AASHTO-accredited lab	Manufactured stone sand and crushed stone per Section 901.05	Mineral filler per ASTM D242	2 and 3	NA	Type II surface course: 16–22 lb/yd^2; Type II intermediate course: 10–20 lb/yd^2; Type III rut filling: 20–40 lb/yd^2	NA	Yes. Apply tack coat prior to application of the treatment as specified in 401.03.05.	Self-propelled vacuum or vacuum-assisted sweeper	Yes. Refer to 421.03.03A.	NA	Yes
Pennsylvania	NA	As listed in Bulletin 14	Cement or hydrated lime, emulsion	A, B, RF, refer to Table A in specification section 483.2	NA	1 coat: Type A mix: 25-30 lb/yd^2; Type B mix: 35-40 lb/yd^2; Type RF mix: 22-38 lb/yd^2 2 coats: Type A mix: 35-40 lb/yd^2; Type B mix: 40-55 lb/yd^2	NA	Yes	Yes	Yes. Refer to 483.3(k).	NA	NA

Table 4. 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							
Delaware	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Maryland	NA	NA	NA	NA	NA	Yes	NA	NA	NA	NA	NA
New Jersey	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pennsylvania	NA	Yes	NA	Yes	NA	Yes	2% maximum per PTM No. 749, if requested	Minimum 1 week	Temperature <140°F	3 in.	NA

Cape sealing: Two states had never constructed cape seals while a third had only constructed a cape seal for one project. The fourth state had only constructed cape seals to cover up bad chip seals. This treatment has not been widely used except to cover defective or noisy chip seals.

Thin bonded overlays: All four states report successfully using this treatment. One state requires spray pavers for application of the treatment, but the others do not. One state is returning to the use of open-graded friction courses (OGFCs) but with polymer modification to provide better performance. Another state is looking at a 4.75 mm Superpave mix, which it reports does not require a spray paver. One state with extensive experience with this technology uses two types of overlays, the traditional NovaChip and a 6.3 mm Superpave mix originally promoted by New York State DOT. Both have performed well. The Superpave mix is placed between ¾ and 1¼ in. See Table 5.

Crack sealing: All four states conduct crack sealing, but application varies between having the counties perform the work and having contractors perform it. Similarly, techniques vary from overbanding to flush filling. Most crack sealing is accomplished with hot-pour sealants, and routing of cracks is seldom done. The largest crack sealing program of all the states, which is accomplished by that state's 67 counties, typically seals 3,000 to 5,000 centerline miles annually. See Table 6.

Scrub sealing: None of the states have used this treatment but all were interested in trying it.

High-friction surface treatments (HFST): These treatments are not considered preservation treatments but are conducted under agency safety programs. All four of the states have used the technology, and it has successfully reduced accidents. These treatments are expensive to apply and are therefore only used at spot locations.

Delamination is the major performance issue with this treatment. One agency recommends waiting 30 days after resurfacing before installing an HFST. Although early applications were cast by hand, most agencies now require machine installation. One agency requires a three-year performance bond on all HFST installations. If any problems occur, the contractor must repair the treatment. See Table 7.

Table 5. Thin bonded overlays

State	Design method	Material type		Construction procedures				
		Aggregate type	Binder type	Crack seal in advance	Spray paver	Tack coat	Thickness	Used as interlayer
Delaware	NA	NA	NA	NA	No	Yes	NA	NA
Maryland	NA	NA	NA	NA	No	Yes	NA	NA
New Jersey	NA	Per Section 901.05	Polymer-modified asphalt binder per 902.08.02	NA	Yes	Yes	NA	NA
Pennsylvania	NA	Per Section 489(b) and as listed in Bulletin 14	Per AASHTO M 320, except as revised in Bulletin 25	Yes, >¼ in.	No	NA	¾–1 in.	NA

Table 6. 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
Delaware	Yes	No	No	No	Yes	No	Per manufacturer	Per manufacturer	Per manufacturer	Yes	In-house
Maryland	Yes	Yes	No	Yes	Yes	NA	Ambient and pavement surface temperatures 45°F and rising	No	Yes	NA	NA
New Jersey	Yes	No	No	1 in. depth	Yes	NA	Per manufacturer	Yes	No	NA	In-house
Pennsylvania	Yes	No	No	½ in. depth as required	Yes	NA	Apply when air temperature is between 40°F and 90°F	No	Yes	NA	Counties

Table 7. High-friction surface treatments

State	Design		Material type			Construction procedures	
	Design procedure	Maximum ADT	Aggregate	Binder	Top size	Aggregate rate	Epoxy rate
Delaware	NA	NA	NA	NA	NA	NA	NA
Maryland	Refer to Section 927	NA	Refer to Section 927	PG 64E-22	Nominal ⅜ in. for 9.5 mm, Nominal ½ in. for 12.5 mm	NA	0.04– 0.06 gal/yd^2 or 0.02–0.04 gal/yd^2, if on new bituminous
New Jersey	Refer to Section 902.03.02	NA	See Tables 902.04.01-1 through 902.04.01-3. See 901.05.01 and 901.05.02.	PG 64E-22 per 902.01.01	Nominal ⅜ in. for 9.5 mm, Nominal ½ in. for 12.5 mm	65–95 lb/yd^2	0.20–0.25 gal/yd^2
Pennsylvania	See Tables 1–6 under 659.2	NA	Bauxite aggregate per Table 2 in Section 659.2(b)	See Table 1 in Section 659.2	Nominal 0.132 in. (No. 6 sieve)	12–15 lb/yd^2	50–65 mils (25–32 ft^2/gal)

Table 8. 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
Delaware	NA	Yes	Yes	NA	NA	NA	Rapid-set or ready-mix	NA	NA	NA
Maryland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
New Jersey	NA	NA	Yes	NA	NA	NA	Fibercrete and TechCrete	NA	NA	NA
Pennsylvania	NA	Yes	Yes	NA	Yes	Yes	Rapid-set or Class AA cement concrete	Yes	NA	NA

Table 9. Full-depth repair

State	Distress type		Design		Construction practices			
	Materials-related distress	Cracking	Repair material specs	Coring in advance	Removal method	Tie bars	Dowel bars	Agency or contractor
Delaware	NA	NA	Class A concrete	NA	Saw cut and lift out	NA	Yes	Contractor
Maryland	NA	NA	NA	NA	Saw cut and lift out	NA	Yes	NA
New Jersey	NA	NA	Precast panels	NA	Saw cut and lift out	Yes	Yes	Contractor
Pennsylvania	NA	Yes	Cast-in-place and precast	NA	Saw cut	Yes	Yes	Contractor

Concrete Pavement Preservation

Partial-depth repair: Two of the four states do not use this treatment because they have very little concrete pavement. These states instead use asphalt concrete (AC) patches. The other two states use elastomeric patching materials and use jack hammers to remove the deteriorated concrete. One state is considering using milling equipment for removal. See Table 8.

Full-depth repair: As with partial-depth repairs, this treatment is not often used by states that have little concrete pavement. One state uses precast pavements and has had good performance with the treatment. One state relies on cast-in-place full-depth repairs, while its turnpike authority has successfully used precast slabs. One state bid a three-year contract for full-depth repairs with the right to terminate the work if it was not satisfactory.

One state experienced issues with continuously reinforced concrete pavement (CRCP) repairs and adopted the South Carolina full-depth repair treatment. Since then, the repairs have performed very well. One state has switched to water-based poly-alpha-methyl-styrene (PAMS) curing compound with successful results. See Table 9.

KEY OBSERVATIONS

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

Preservation Successes

- Making emulsion suppliers responsible for compatibility between the aggregate and emulsion improved chip seal success.
- Using a good chip seal design process is critical to satisfactory performance.
- Fogging chip seals after placement is considered good practice.
- Fog sealing in advance of micro surfacing improves performance; pavement marking removal, where necessary, also improves performance.
- One state has an in-service concrete pavement that is 102 years old, indicating the benefits of preserving long-life pavements.

Preservation Challenges

- Aggregate loss in chip seals constructed with limestone aggregates occurred as a result of compatibility issues between the aggregate and the emulsion. Aggregate loss was experienced from the day of construction.
- The states recognized that there is a need for more and better training, especially for quality assurance.
- Treatment selection can be affected by ADA requirements.

SUMMARY

Eight asphalt and two concrete pavement preservations treatments were discussed in depth (see Figures 1–10). All four states have used crack sealing, chip seals, ultrathin bonded wearing courses, cold in-place recycling, and micro surfacing as asphalt preservation treatments. Only two of the states use full- and partial-depth repairs of concrete pavements because the other two states have very little concrete pavement.

The experience level between the states varied greatly in terms of treatment application and performance evaluation. All four states successfully use HFST as part of their safety programs, though this treatment is limited to spot locations due to its high cost.

Slurry Pavers, Inc.

Figure 1. Chip sealing

National Center for Pavement Preservation

Figure 2. Micro surfacing

Pavement Recycling Systems

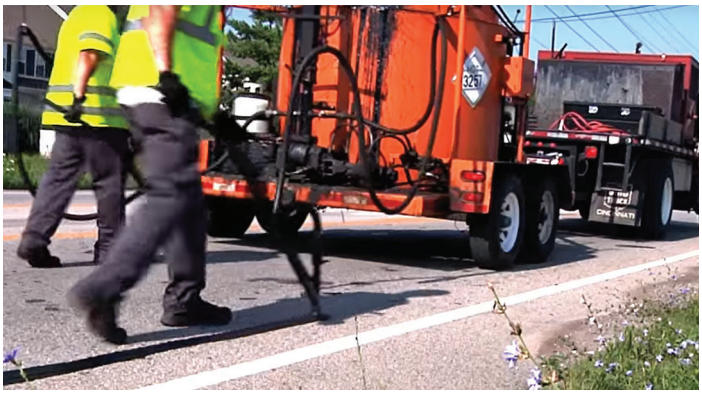
Figure 3. Cold in-place recycling

Strawser Construction Inc.

Figure 4. Cape sealing

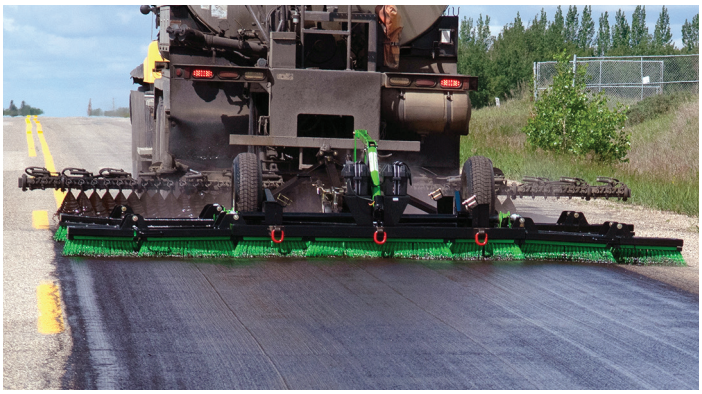
All States Materials Group

Figure 5. Thin bonded overlay



National Center for Pavement Preservation

Figure 6. Crack sealing



Saskatchewan Ministry of Highways and Infrastructure

Figure 7. Scrub sealing

Kwik Bond Polymers

Figure 8. High-friction surface treatment

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Figure 9. Partial-depth repair

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Figure 10. Full-depth repair

AGENCY SPECIFICATIONS

The relevant agency specifications are available at the following websites:

Delaware: https://deldot.gov/Publications/manuals/standard_specifications/

Maryland: https://www.roads.maryland.gov/mdotsha/pages/sscm.aspx?PageId=853&lid=SSP

New Jersey: https://www.state.nj.us/transportation/eng/

Pennsylvania: http://www.dot.state.pa.us/public/PubsForms/Publications/Pub_408/408_2016/408_2016_6/408_2016_6.pdf

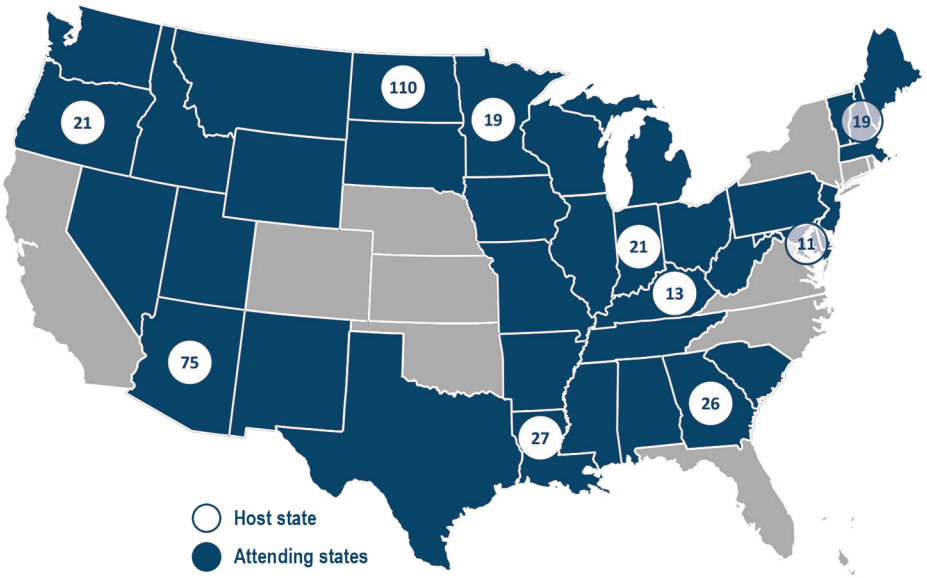
ONLINE RESOURCES

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