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: INDIANA, ILLINOIS, MICHIGAN, AND OHIO

EDC-4 PEER-TO-PEER EXCHANGES

INTRODUCTION

On April 23rd, 2019, an FHWA-sponsored EDC-4 "How" Pavement Preservation State Peer-to-Peer Exchange was conducted in Indianapolis, Indiana, with 3 FHWA representatives, 15 department of transportation (DOT) representatives from Indiana, 2 from Illinois, 1 from Michigan, and 1 from Ohio. 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. Indiana 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	Precast slabs
Cold in-place recycling (CIR)	Diamond grinding
Ultrathin bonded wearing course	—
Scrub seal	—
Cape seal	—

SUMMARY OF IMPORTANT ISSUES OR SUCCESSES

Asphalt Concrete Pavement Preservation

Chip sealing: All four states successfully place chips seals, with two using contracted work crews and two using maintenance crews. Applications include roadways with average daily traffic (ADT) counts ranging from 1,000 to 5,000, and CRS-2P is the most commonly used binder. Sweeping times among the states range from four hours after placement to the next morning. Fog seal dilution at the manufacturing facility should generally be used.

One state improved chip seal performance by lowering the allowable content of chert aggregate, and another state improved performance by switching from siliceous to limestone aggregate. Two states pay for aggregate by the square yard, while the other two pay by the ton. Two states report that they require warranties on chip seal performance. Chip seal performance in one state ranged from 7 to 10 years. Concerns with chip sealing over rumble strips were expressed. See Table 2.

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
Indiana	NA	1,000	Limestone	CRS-2P	⅜ in.	≤1.5%	See table in Section 404.04	See table in Section 404.04	Minimum 3 roller applications	24 hours	Yes	Cover pavement markings	NA
Illinois	NA	1,000	Nominal ⅜ in. or nominal ½ in.	CRS-2P	CA 15 and 16	NA	15–25 lb/yd²	Prime coat: 0.25–0.5 gal/yd² Cover coat: 0.20–0.50 gal/yd²	Pneumatic-tire roller	NA	Yes	NA	No, limit speed
Michigan	NA	5,000	34CS per specification section 902	PG 64-22 asphalt binder or CSS-1h emulsion	⅜ in.	NA	Apply coarse aggregate at 20–24 lb/yd²	Apply asphalt emulsion at 0.39–0.46 gal/yd²	Minimum 3 roller applications	Before opening to traffic	Yes, only single chip, diluted at plant	Issues chipping over thermoplastic	NA
Ohio	NA	NA	Gravel and limestone	CRS-2P	Aggregate Type A (nominal ¾ in.), Type B (nominal ⅜ in.), limestone, or washed dolomite	NA	Determine the initial binder application rates and aggregate application rates for the test strip to achieve ⅔ aggregate embedment	Type A: an initial target rate of 0.37 ± 0.03 gal/yd²; Type B: an initial target rate of 0.35 ± 0.03 gal/yd²; double chip seal: a target rate of 0.36 ± 0.03 gal/yd²	Yes, within 5 minutes	Within 4 hours	Yes	NA	Yes, 25 mph

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
Indiana	NA	⅜ in. minus	CSS-1H	NA	NA	NA	Cracks in the pavement in excess of ¼ in. shall be filled in accordance with 408 prior to placement of warranted micro surfacing	The pavement surface shall have tack coat applied in accordance with 406 prior to placement of warranted micro surfacing	NA (removal of durable pavement marking required)	NA	2	Yes
Illinois	NA	NA	NA	NA	NA	NA	NA	Yes, when oxidized	NA	NA	2	NA
Michigan	Spec.	Nominal ³⁄₁₆ in.; sand, gravel, crushed stone, iron blast furnace slag, reverberatory furnace slag, or a blend of aggregates	CSS-1hM, CSS-1mM (7%–8.5%, dry weight, 2FA aggregate), (6.5%–8%, dry weight, 3FA aggregate)	2FA and 3FA	Yes, 0.25%–3% by dry weight aggregate	3FA (35 lb/yd²), 2FA (30 lb/yd²), single course (24 ± 2 lb/yd²)	NA	Yes, 0.035–0.070 gal/yd²	NA	Yes	2	Yes
Ohio	Spec.	Nominal ³⁄₁₆ in. (Table 421.02-3)	CSS-1hM	NA	Mineral filler content of 0.3–2.5 portland cement (ASTM C150,Type I)	Minimum 14 lb/yd² by dry aggregate weight for leveling course, and 18 ± 1 lb/yd² by dry aggregate weight for surface course. Apply two courses at minimum combined rate of 32 lb/yd² by dry aggregate weight.	Yes	Yes	NA	1,000 ft long x lane width	2	NA

Micro surfacing: All four states have used micro surfacing, but most states have experienced performance issues with the treatment. Performance issues have generally consisted of delamination, but one state reported cracking as the main issue and another noted deterioration of underlying patches. Although all four states allow the use of truck-mounted equipment, most prefer continuous equipment. Double micro surfacing is preferred by three of the four states. The fourth state does not experience rutting issues and therefore believes a single application is sufficient. Most states believe fog seals should be placed in advance of micro surface placement, particularly on highly oxidized surfaces. Raised pavement markings were also noted as a concern, and removal prior to application was recommended by the State representatives.. See Table 3.

Cold in-place recycling (CIR): Although all four states have used this treatment at some point, their experience with it has been limited. Two states did not consider CIR a preservation treatment at all. One state had experience with both central plant and in-place recycling. Some issues raised regarding this treatment were the time spent waiting for the pavement to dry after significant rainfall and shoulder deterioration when construction traffic is placed on the shoulder during CIR construction activities. When conducting deep CIR, such as 6 in., it is difficult to achieve a consistent density with depth. See Table 4.

Ultrathin bonded wearing course: One state has not used this treatment, and the other three have only had limited experience with it. Some experience has been good, and some less so. Typical issues with this treatment consisted of the wearing course cupping over the transverse joints in concrete pavements and icing of the surfaces during wintertime on all pavements. The states also remembered several bad historical experiences with conventional open-graded friction courses. The longest lasting project noted has been in service for 11 to 12 years. One state is expanding the use of this treatment on asphalt concrete (AC) pavements but currently does not have spray pavers available. See Table 5.

Scrub sealing: Three of the four states did not see value in this treatment because they felt chip seals sufficiently fill the need. Only limited experience was available because few scrub seal projects have been constructed. The state with the most experience with this treatment uses its chip seal emulsion for scrub seals. That state sweeps the road in advance but does not blow out the cracks.

Cape sealing: Two of the states have had little to no experience with this treatment, and the other two states have had somewhat limited experience. However, all were in favor of the use of this treatment. One state has had experience with this treatment since 2005. It is common to use the standard chip seal specification for the lower portion of the cape seal and the standard micro surfacing specification for the upper portion. See Table 6.

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							
Indiana	NA	NA	Yes	Yes	Per plan	Yes	Water content 1 per 500 ft, moisture content 1 per day	Minmum 3 days and less than 3% moisture remaining in the mixture, or material has remained in place for minimum 10 days	No raveling or permanent deformation	NA	NA
Illinois	NA	NA	NA	NA	NA	NA	NA	NA	NA	3 in. maximum	NA
Michigan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ohio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5. 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
Indiana	NA	½, ⅜, or ³⁄₁₆ in.	PG 64-22 ESAL <10,000,000, PG76-22 ≥10,000,000	NA	NA	NA	NA	NA
Illinois	NA	NA	NA	NA	NA	NA	NA	NA
Michigan	Asphalt binder to produce film thickness of minimum microns	30SS (nominal ⅜ in.) and 27SS (nominal ½ in.)	PG 64-28P, PG 70-28P, PG 70-22P by region	NA	No	0.20 gal/yd^2	73–83 lb/yd^2	NA
Ohio	NA	NA	NA	NA	NA	NA	NA	NA

Table 6. Cape sealing

State	Design method	Material type		Construction procedures						
		Aggregate type	Binder type	Chip seal top size	Chip spread rate	Chip binder rate	Surface type	Delay between layers	Marking problems	Rumble strip issues
Indiana	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Illinois	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	NA	NA	NA	NA
Michigan	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	Same as chip seal and micro seal	NA	NA	NA	NA
Ohio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Concrete Pavement Preservation

Partial-depth repair: Two of the states perform partial-depth repairs in advance of placing AC overlays and use hot-mix asphalt for the repairs. This practice is a result of the extent of joint-associated distress that occurs in these states' pavements. One of these states has even begun making a distinction between traditional partial-depth repair and joint-associated distress repair. For the two states that repair joint-associated distress in the manner described above, milling machines are usually used. The other two states try to use their own maintenance crews to reach the spalled areas sooner. These two states use elastomeric repair materials to achieve more traditional partial-depth repairs. See Table 7.

Precast slabs: One state has not used this technology, while two other states have developed their own designs for the use of this treatment. All four states consider this a good treatment to use when the costs are not excessive. The use of precast slabs is considerably more expensive than cast-in-place technologies, and the states only consider it when traffic and placement conditions warrant it. One state's tollway organization, which manages roadways in a high-density urban area, prefers the use of precast slabs to allow early access to local businesses. This organization uses a proprietary system. A second state has developed its own specifications and is planning to evaluate all available systems in the future. This state has placed as many as 40 panels per shift. Diamond grinding is typically required after placement on larger projects. See Table 8.

Diamond grinding: Three of the four states use this treatment either for bump grinding or bridge decks. When diamond grinding is used on bridge decks, the states commonly add an additional 1/4 in. in thickness for future removal. The fourth state grinds for smoothness and is considering using a threshold International Roughness Index (IRI) value of 110 as the trigger for diamond grinding. This state believes that by grinding soon after construction, the pavement will last longer. One state only performs longitudinal grooving on pavements and diamond grinding on bridge decks. See Table 9.

Table 7. 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
Indiana	Yes	Yes	Yes	NA	Yes	Yes	3U18	Yes	Yes	No
Illinois	Yes	Yes	NA	No	Yes	Yes	AC	No	No	No
Michigan	NA	NA	NA	NA	NA	NA	TechCrete and Fibercrete	NA	NA	NA
Ohio	Yes	NA	Yes	NA	Yes	Yes	AC	Yes, tack coat	NA	NA

Table 8. Precast slabs

State	Design				Use		Construction practices	
	Roman Stone	Illinois Tollway	Fort Miller	Caltrans	Demo project	Routinely use	Bedding type	Panels per shift
Indiana	No	Yes	Yes	In-house design	Yes	No	NA	40
Illinois	NA	NA	Yes	NA	NA	NA	NA	NA
Michigan	NA	NA	NA	In-house design	Yes	No	NA	NA
Ohio	NA	NA	NA	NA	NA	NA	NA	NA

Table 9. Diamond grinding

State	Purpose of grinding				Construction practices			
	Ride quality	Friction	Noise	Buried treasure	Blades per foot	Head width	Smoothness spec	Construction issues
Indiana	Bump grind	No	NA	NA	NA	Minimum 3 ft wide	Profilograph	NA
Illinois	Seldom	Yes	NA	NA	NA	Minimum 3 ft wide	NA	NA
Michigan	Yes	Yes	NA	NA	NA	NA	ASTM E965	NA
Ohio	Yes	NA	NA	NA	53–57	Minimum 3 ft wide	95 in./mi	NA

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

- Reducing the amount of chert aggregate in chip seals provides better performance.
- Payment for aggregate by the square yard and binder by the ton provides better application control.
- Calendar limitations on chip seal placement and lower posted speed limits improve chip seal success.
- One state recognized the need to diamond grind soon after construction to increase concrete pavement performance and service life and grinds when the surface reaches an IRI of 110 in./mi.
- The service life of ultrathin bonded wearing courses in one state extends to 11 to 12 years.

Preservation Challenges

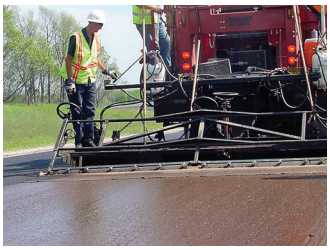
- Lightweight aggregate for chip seals costs almost twice as much as other types of aggregate, and production capability for this type of aggregate is limited.
- Air-blown slag aggregate can create green leachate after placement in a fill or stockpile. Slag results in less windshield damage than other types of aggregate but breaks down during transport.
- Trap rock chip seals are opened to traffic later than chips seals with other types of aggregate because trap rock is not as absorptive.
- When traffic is diverted onto shoulders during CIR construction, the shoulders sometimes begin to deteriorate significantly.
- For partial-depth repairs, some states do not use a warranty due to the difficulty of checking the repairs.
- Several treatments that were discussed are not widely used nor well accepted.

SUMMARY

Six asphalt and three concrete pavement preservation treatments were discussed in depth (see Figures 1–9). All four states use chip seals and micro surfacing as asphalt preservation treatments. The next most commonly used treatments are ultrathin bonded wearing courses, CIR, and partial-depth repairs. Cape seals and scrub seals are not routinely used treatments for AC pavements. Precast full-depth repairs are used in high-density urban areas where access to local businesses is a concern and limited construction time is available.

Slurry Pavers, Inc.

Figure 1. Chip sealing



National Center for Pavement Preservation

Figure 2. Micro surfacing

Pavement Recycling Systems

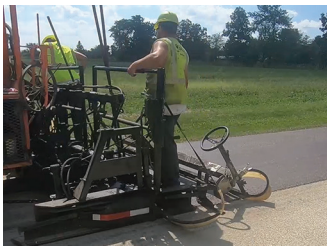
Figure 3. Cold in-place recycling

All States Materials Group

Figure 4. Ultrathin bonded wearing course

Saskatchewan Ministry of Highways and Infrastructure

Figure 5. Scrub sealing

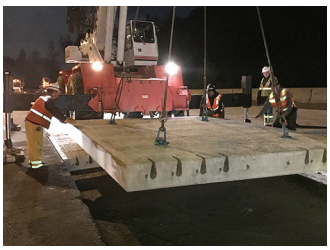


Strawser Construction Inc.

Figure 6. Cape sealing

ACPA

Figure 7. Partial-depth repair



Shiraz Tayabji

Figure 8. Precast slabs

International Grooving and Grinding Association

Figure 9. Diamond grinding

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

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AGENCY SPECIFICATIONS

The relevant agency specifications are available at the following websites:

Indiana: https://www.in.gov/dot/div/contracts/standards/

Illinois: http://idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/highway-standards-and-district-specific-standards

Michigan: https://www.michigan.gov/mdot/0,4616,7-151-9622---,00.html

Ohio: https://transportation.ohio.gov/wps/portal/gov/odot/working/publications/spec-book

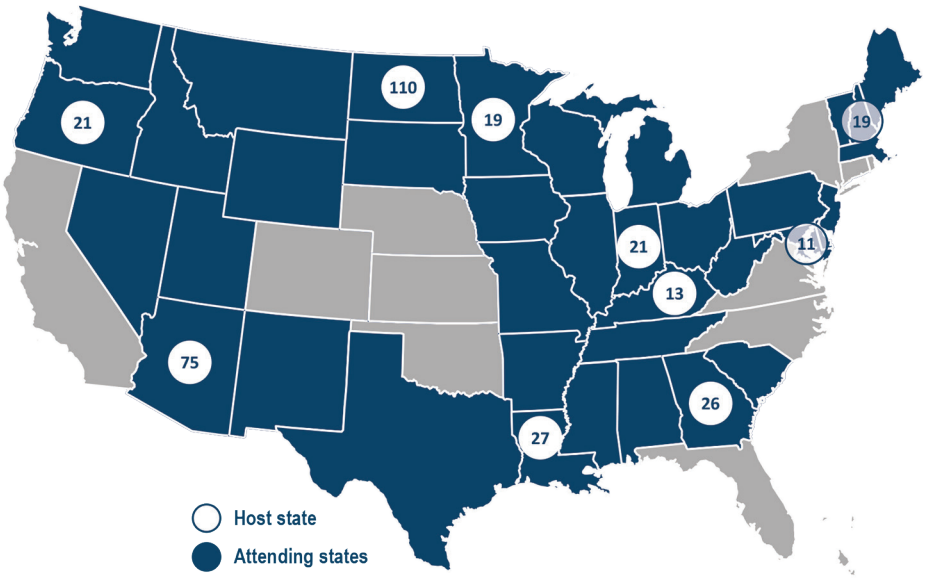
ONLINE RESOURCES

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