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

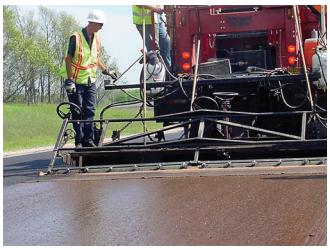
- Lightweight aggregate for chip seals costs almost twice as much as other types of aggregate, and production capability for this type of aggregate is limited.
- Air-blown slag aggregate can create green leachate after placement in a fill or stockpile. Slag results in less windshield damage than other 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

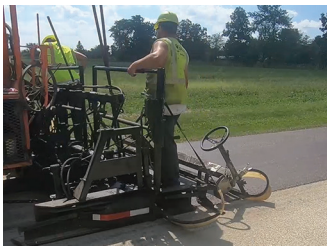
***Figure 3. Cold in-place recycling***

All States Materials Group

***Figure 4. Ultrathin bonded wearing course***

Saskatchewan Ministry of Highways and Infrastructure

***Figure 5. Scrub sealing***

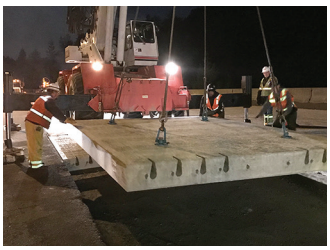


Strawser Construction Inc.

***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/.

**KEY WORDS**
pavement, preservation, peer-to-peer



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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

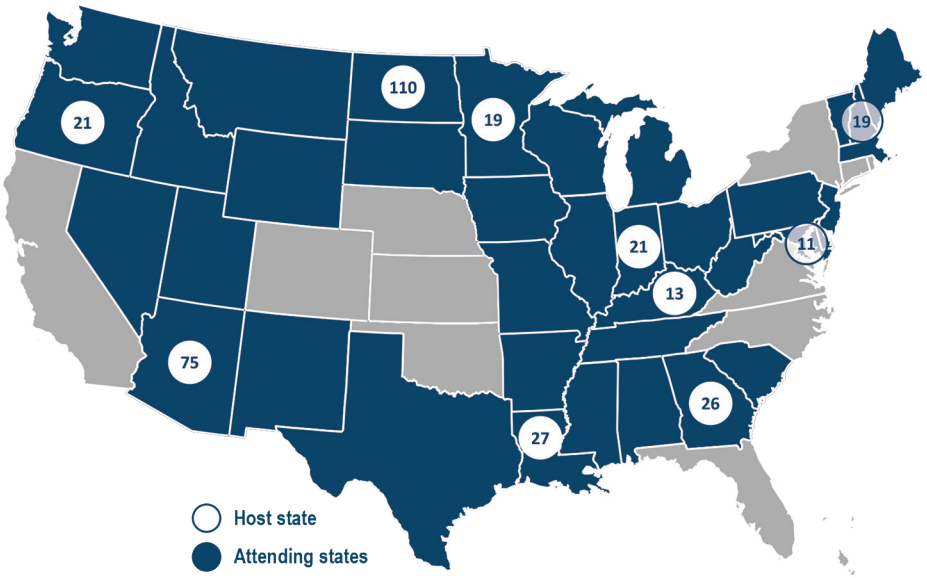
## ONLINE RESOURCES

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*