Practices and Lessons Learned For Cold and Hot In-place Recycling

FHWA is the source for all images unless otherwise noted.

Adam Hand, PhD, P.E. – University of Nevada Reno

Tim Aschenbrener, P.E. – Federal Highway Administration

U.S. Department of Transportation

Federal Highway Administration

November 9, 2023

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- None of the AASHTO and ASTM specifications mentioned in this presentation are required under Federal requirements.

Abbreviations & Acronyms

U.S. Department of Transportation
Federal Highway Administration

- AASHTO – American Association of State Highway and Transportation Officials
- ARRA – Asphalt Recycling and Reclaiming Association
- CCPR – Cold Central Plant Recycling
- CIR – Cold In-place Recycling
- DDIAPT – Demonstration and Deployment of Innovative Asphalt Pavement Technologies
- DOT – Department of Transportation
- FDR – Full-depth Reclamation
- FHWA – Federal Highway Administration
- FLH – Federal Lands Highway
- GTR – Ground Tire Rubber
- HIR – Hot In-place Recycling
- HMA – Hot Mix Asphalt
- INDOT – Indiana DOT
- IS – Information Series
- ITS – Indirect Tensile Strength
- ME – Mechanistic Empirical
- NAPA - National Asphalt Pavement Association

Abbreviations & Acronyms

- NCHRP - National Cooperative Highway Research Program
- NMDOT – New Mexico DOT
- NP – National Park
- NYSDOT – New York State DOT
- PCR – Pavement Condition Rating
- PG – Performance Grade
- PM – Polymer Modified
- QA – Quality Assurance
- QC - Quality Control
- QCP – Quality Control Plan
- RAP - Reclaimed Asphalt Pavement
- RAS - Recycled Asphalt Shingles
- SCDOT – South Carolina DOT
- TSR – Tensile Strength Ratio
- UCS – Unconfined Compressive Strength
- VDOT – Virginia DOT

Outline

U.S. Department of Transportation
Federal Highway Administration

- Introduction and Background
- Performance, Sustainability, Cost
- Project Selection
- Pavement and Mix Designs
- Production
- Summary

Image Source: Adam Hand

DDIAPT Innovation Area:

Resource Responsible use of Materials for Flexible Pavement Systems

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Innovation Area	Task	Topic	Tech Brief or Report	FHWA Document
Resource Responsible use of Materials for Flexible Pavement Systems	B.1	High Reclaimed Asphalt Pavement (RAP) Mixtures	Resource Responsible Use of Reclaimed Asphalt Pavement in Asphalt Mixtures	FHWA-HIF-22-003
	B.1.2	Cold & Hot In-place Recycling	Asphalt Pavement Recycling Technologies	FHWA-HIF-23-036
	B.2	Reclaimed Asphalt Shingles (RAS) Modified Binders and Mixtures	Practices and Lessons Learned when Using Reclaimed Asphalt Shingles in Asphalt Mixtures	FHWA-HIF-22-001
	B.3	Asphalt Rubber-Modified Binders	Effective Use of GTR Modified Asphalt Binder in Asphalt Mixtures	FHWA-HIF-22-011
			Resource Responsible Use of Recycled Tire Rubber in Asphalt Pavements	FHWA-HIF-20-043

https://www.fhwa.dot.gov/pavement/recycling/

Cold & Hot In-place Recycling Methods

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- Cold In-place Recycling
  - CIR
- Full Depth Reclamation
  - FDR
- Cold Central Plant Recycling
  - CCPR
- Hot In-Place Recycling
  - HIR

Images Source: Adam Hand

Objectives

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- Learn details of positive State DOT practices.
- Collect and communicate experiences, lessons learned and performance information.
- Identify gaps for creation of research needs statements.

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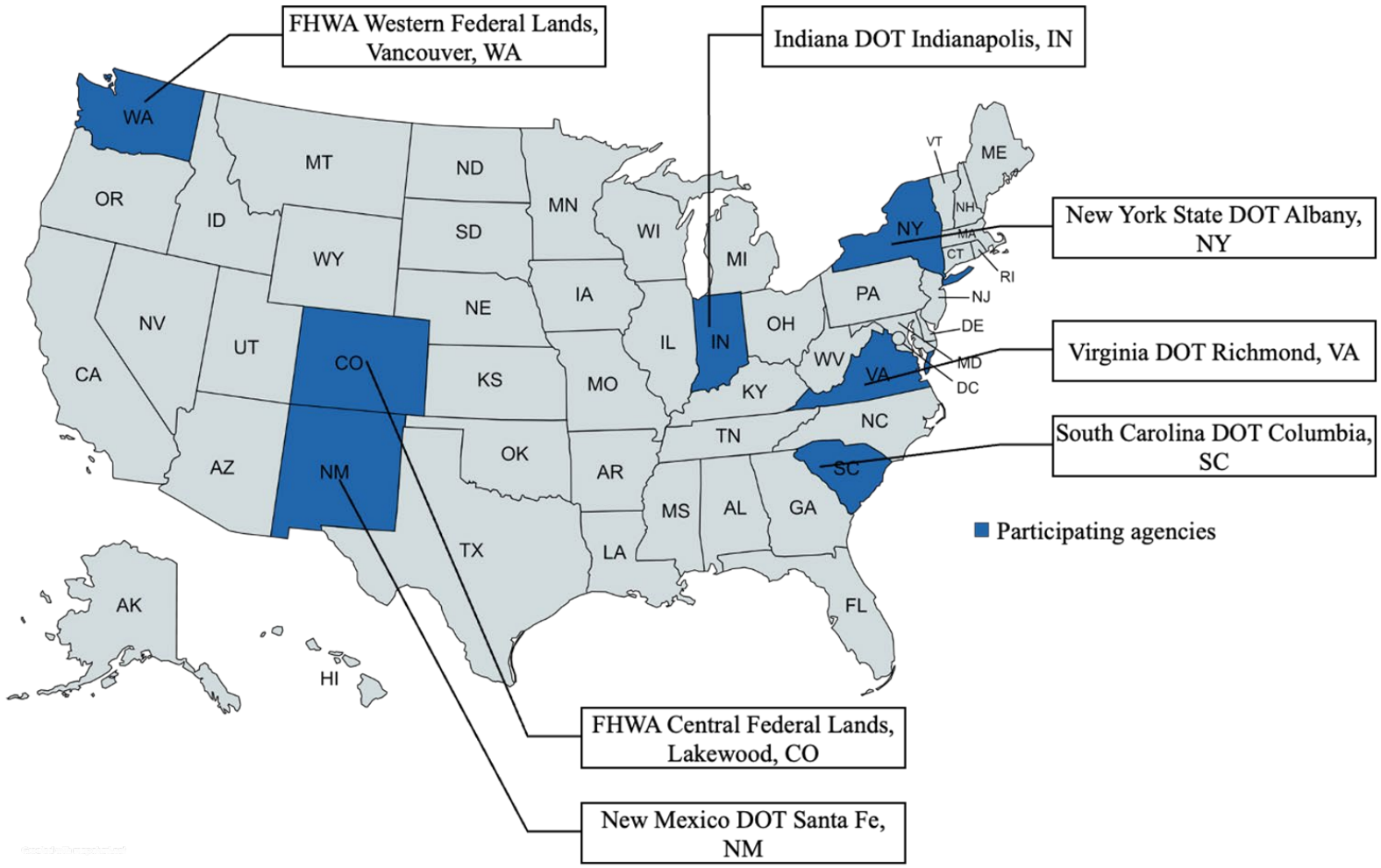

Image Source: University of Nevada Reno

Participating Agencies

- 6 agencies
  - FLH
  - INDOT
  - NMDOT
  - NYSDOT
  - SCDOT
  - VDOT
- Virtual site visits and interviews

Federal Lands Highway Divisions

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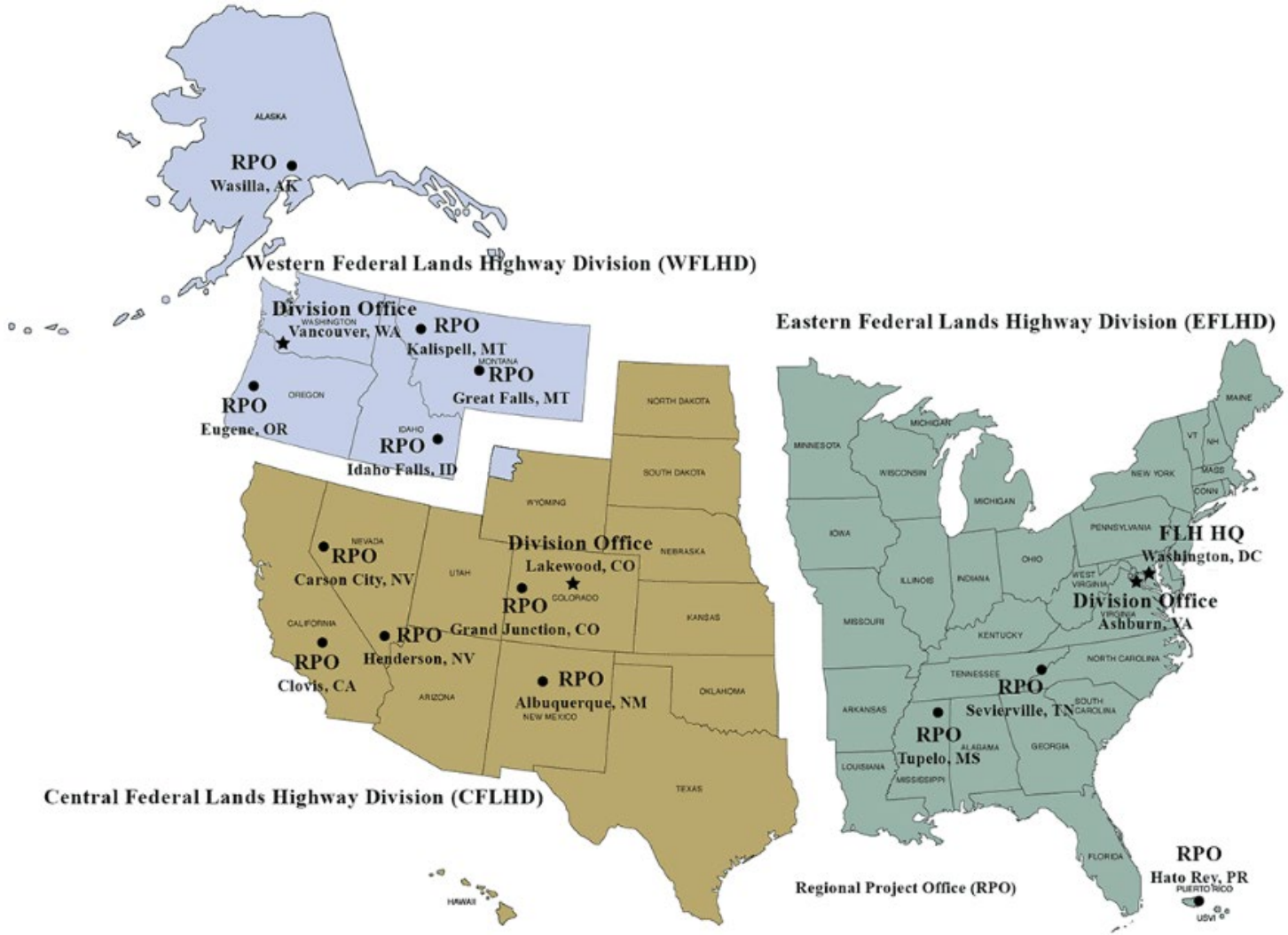

Scope

- CIR, CCPR, FDR & HIR
- Kick-off/planning meeting
- 2 or 3 - day virtual visits
- Agency reports
- Summary report
- FHWA TechBrief
- Webinar

TechBrief

The Asphalt Pavement Technology Program is an integrated national effort to improve the long-term performance and cost-effectiveness of asphalt pavements. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, the program's primary goals are to reduce congestion, improve safety, and foster technology innovation. The program was established to develop and implement suggestions, methods, procedures, and other tools for asphalt pavement materials selection, mixture design, testing, construction, and quality control.

Office of Preconstruction, Construction, and Pavements
FHWA-HIF-23-036
Date: July 2023

U.S. Department of Transportation
Federal Highway Administration

Asphalt Pavement Recycling Technologies

This Technical Brief summarizes techniques successfully used by State DOTs and Federal Lands Highway Divisions to implement use of cold asphalt and hot in-place asphalt recycling technologies.

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.

Introduction

State Departments of Transportation (DOT) and other agencies are facing greater pressure to integrate sustainability into pavement construction and reduce material costs at the same time.(1) The asphalt industry recycles over 99 percent of reclaimed asphalt pavement (RAP); the majority of it is recycled back in asphalt pavement.(2) This has been driven by the desire for cost-effective alternatives to virgin asphalt binder initially. In some urban areas, RAP supply exceeds demand, resulting in stockpiles of excess RAP; in some rural areas available supply of RAP can be less than demand.(3) Hauling excess RAP from urban to rural areas is not a sustainable practice. This challenge can be addressed using a portable cold central recycling plant or cold in-place or hot in-place recycling techniques. These technologies can also be used in urban areas to increase recycling rates. A National Asphalt Pavement Association (NAPA) 2021 construction season survey stated that 25 companies collectively indicated that they used over 4.8 million tons of RAP by performing in-place recycling processes during the 2021 construction season.(2)

This TechBrief focuses on these sustainable asphalt pavement recycling techniques (APRT): cold in-place recycling (CIR), full depth reclamation (FDR), cold central plant recycling (CCPR), and hot in-place recycling (HIPR).

Cold recycling is a method of reconstructing any flexible pavement where the need arises from structural failures. CIR is a pavement rehabilitation method in which some fraction of the existing pavement thickness (up to about 4 inches) is milled up, crushed and screened, then mixed with asphalt cement (or emulsified/foamed asphalt) and replaced to serve as a high-quality base material upon which to pave.(1) FDR is a pavement rehabilitation method in which the existing full pavement thickness and some portion of the underlying material is pulverized, blended, and stabilized (with cement, lime, foamed/emulsified asphalt, etc.) to provide a high-quality base material upon which to pave. HIPR is a pavement rehabilitation method in which the existing asphalt pavement surface

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Agency Use of Technologies

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Recycling Technologies Used

Item	FLH	INDOT	NMDOT	NYSDOT	SCDOT	VDOT
CIR	Yes	Yes	Yes	Yes	No	Yes
CCPR	Yes	Yes	Yes	V. Limited	No	Yes
FDR	Yes	Yes	Yes	No	Yes	Yes
HIR	No	No	Yes	Yes	No	No

Years of Experience

Item	FLH	INDOT	NMDOT	NYSDOT	SCDOT	VDOT
CIR	50	5-10	3	20^{+}	n/a	10^{+}
CCPR	15	5-10	8	5^{+}	n/a	10^{+}
FDR	40	5-10	9	n/a	7	13^{+}
HIR	50	n/a	20^{+}	15^{+}	n/a	n/a

Agency Use of Technologies

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Percentage of Recycling Program

Item	FLH[1]	INDOT	NMDOT	NYSDOT	SCDOT	VDOT
CIR	6% (5%)	38%	10%	50 to 65%	0%	20%
CCPR	6% (5%)	12%	40%	<1%%	0%	18%
FDR	88% (80%)	50%	50%	0%	100%	62%
HIR	0%	0%	n/a	35 to 50%	0%	0%

[1]≈10% of FLH Recycling in RAP Millings

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Data collection vehicle for roadway condition

Performance & Sustainability

- *"A total of 40 agencies responded… Most cold recycling programs pave less than 50 lane-miles per year. Cold recycling is frequently used on roadways with annual average daily traffic (AADT) under 10,000, but more experienced agencies use cold recycling on roadways with AADTs between 10,000 and 25,000."*

- *"The reported service life of cold recycled pavements ranges from 20 to 34 years when the cold recycled mix is used in conjunction with an overlay. The service life is somewhat shorter and more variable when chip seals are used as the wearing surface. Poor drainage can reduce the service life by 30% or more."*

- *"Cold recycling with an overlay can reduce the cost of a project by 40% to 60% compared to a conventional mill and fill. Greenhouse gas emissions can be reduced by about 50% compared to a conventional mill and fill."*

https://nap.nationalacademies.org/catalog/26319/practice-and-performance-of-cold-in-place-recycling-and-cold-central-plant-recycling

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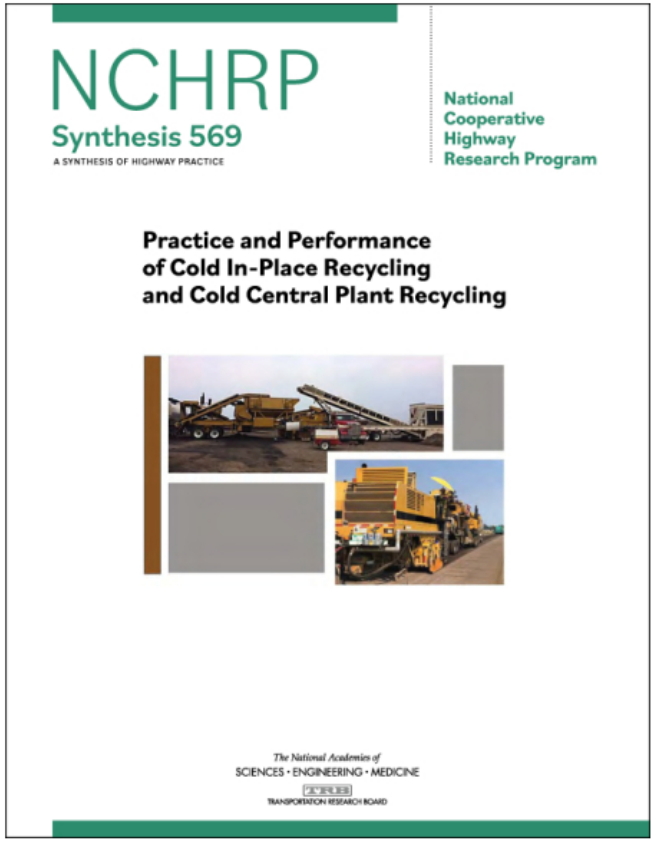


The use of a synthesis is not a Federal requirement.

Performance & Sustainability

Additional Resources:

- 2010 Robinette and Epps: LCCA & LCA Benefits (TRR 2179, 2010)
- 2015 FHWA: Towards Sustainable Pavement Systems
  https://www.fhwa.dot.gov/pavement/sustainability/ref_doc.cfm
- 2019 Gu et al: CIR & CCPR vs. New HMA, Energy consumption reduced 56-64% & GHG reduced 39-46%

  Journal of Cleaner Production 208 (2019) 1513e1523
- 2022 Amarh et.al: 10 VDOT rehabilitation projects including (CIR), CCPR, & FDR, HMA; pavement recycling projects used for interstate reconstruction and primary route restorative maintenance yielded lower global warming (GW) than non-recycling approaches.

  Transportation Research Record
  2022, Vol. 2676(6) 75–86

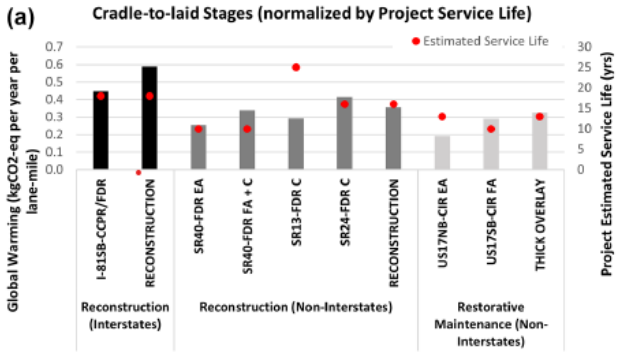
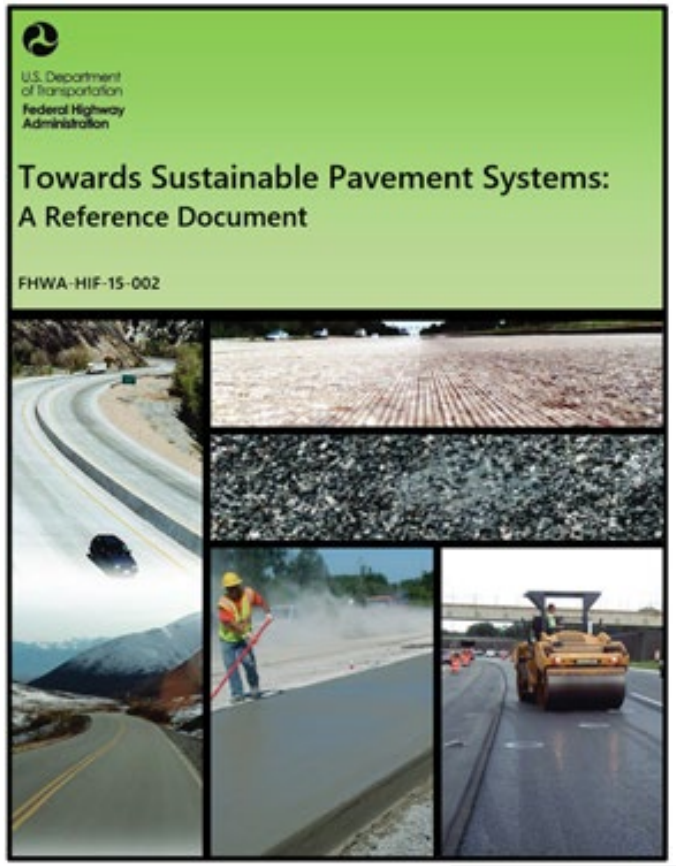


Image Source: Transportation Research Record, 2022, Vol. 2676(6) 75–86



INDOT FDR Projects

- FDR vs. Conventional Rehabilitation Structural Performance

- 40-70% Cost Savings

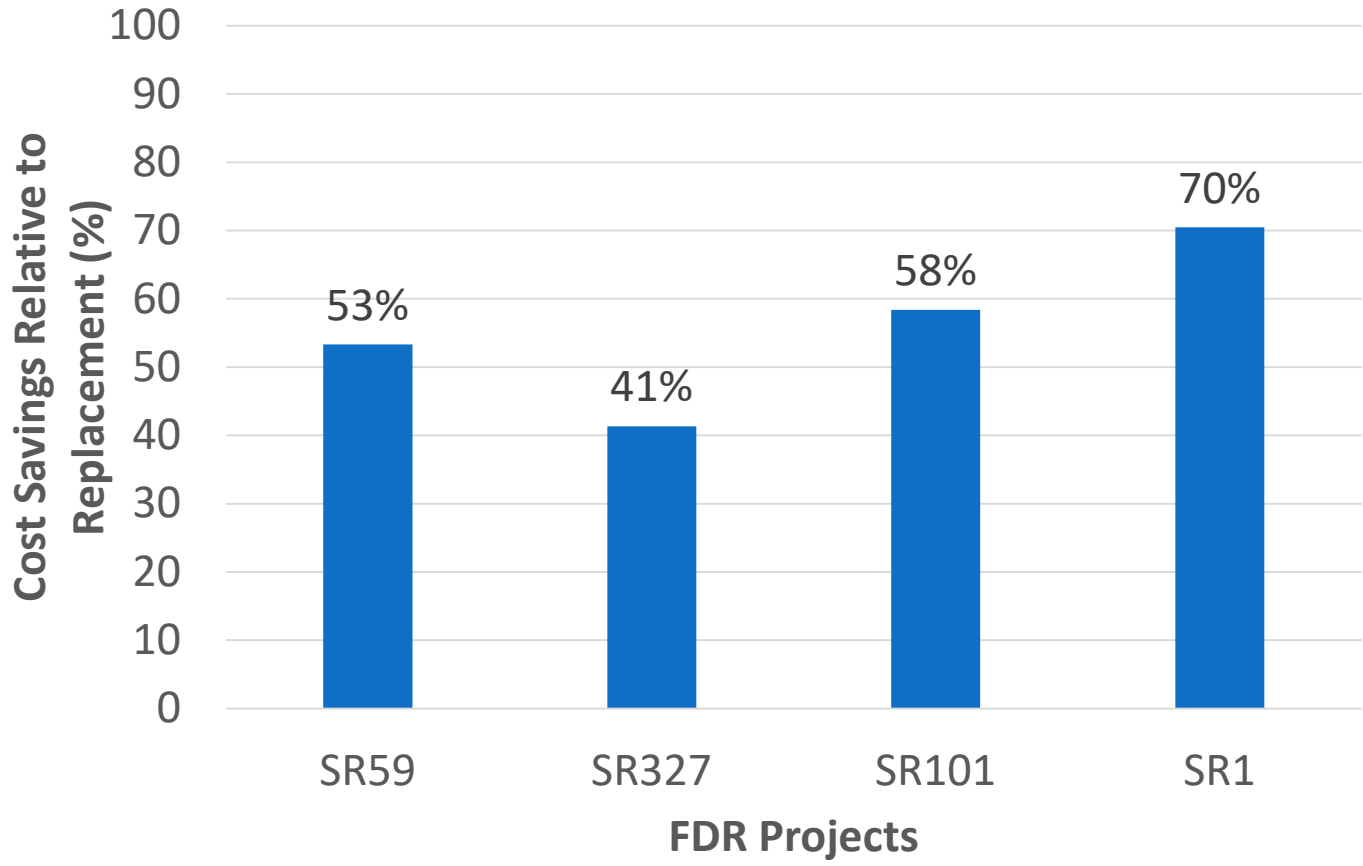


Image Source: Indiana Department of Transportation

FLH: CIR Cost and Performance

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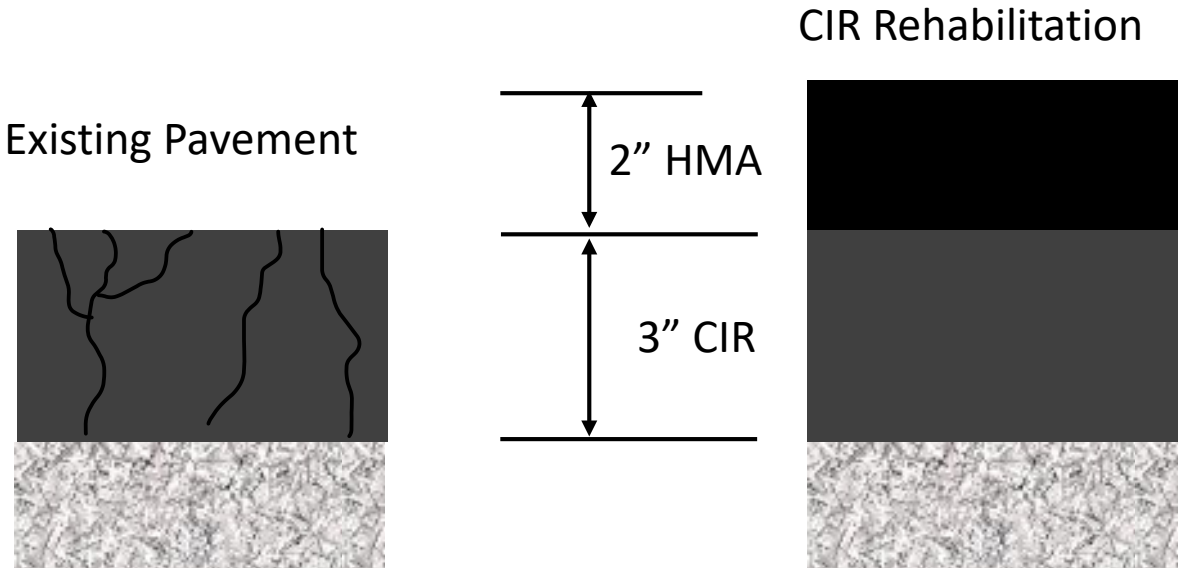
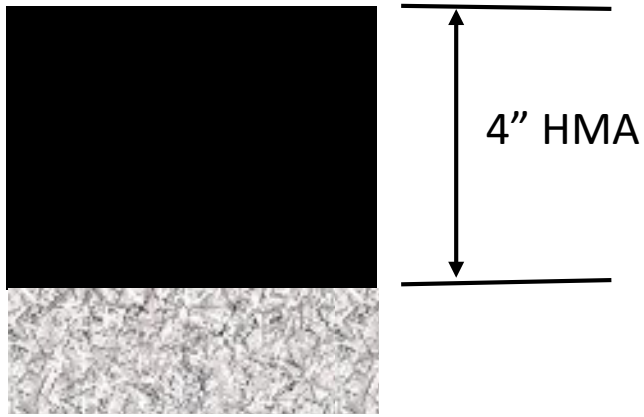
Federal Highway Administration

- The Economics….



40% Higher Cost than CIR Rehabilitation



FLH: Performance

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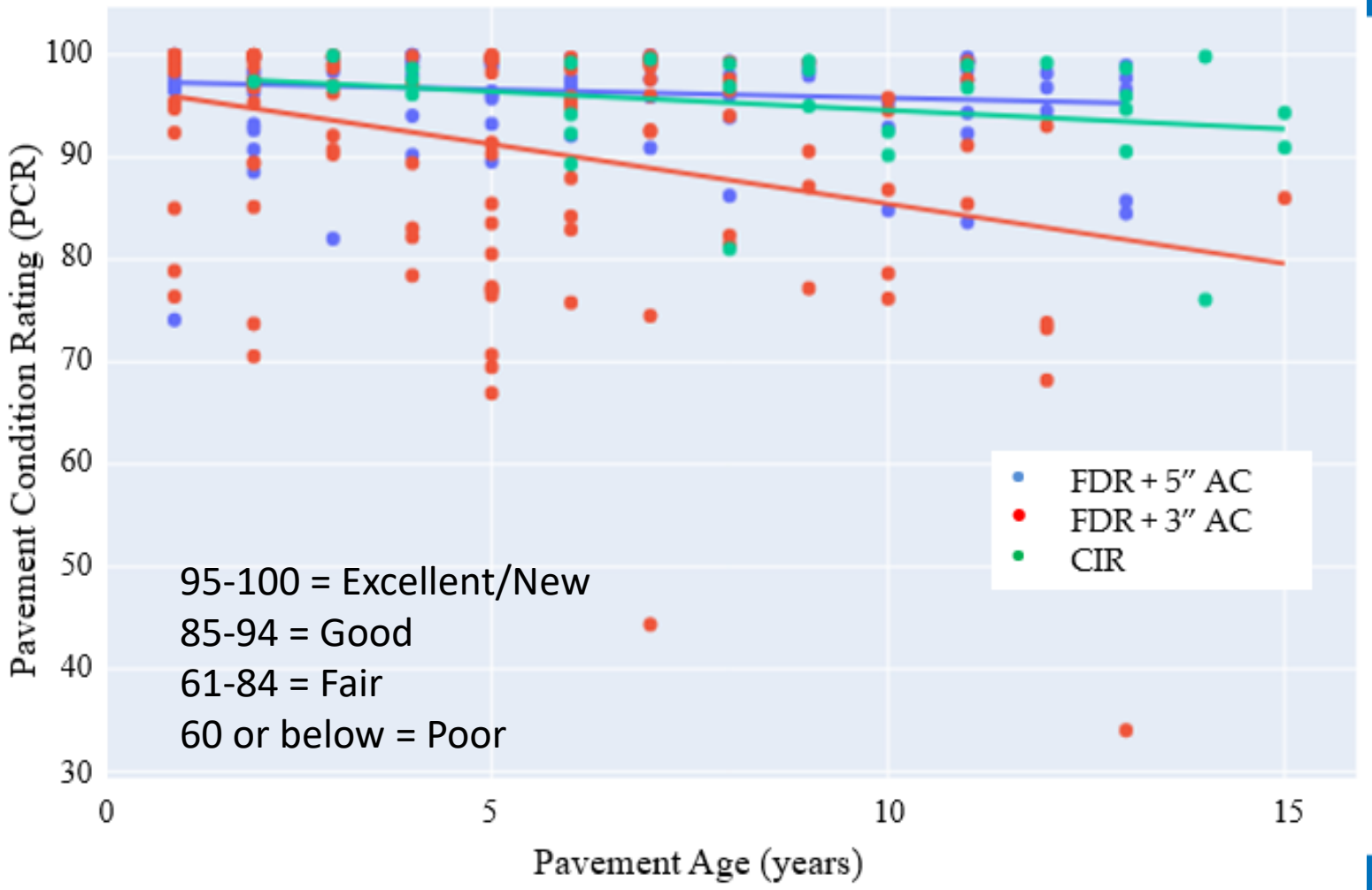
- FLH Positive Performances
  - CIR
  - FDR
  - Others

- PCR = 0.6 (SCR) = 0.4 (RCI)
  - SCR = Surface Condition Rating
    - Rutting, cracking, patching
  - RCI = Roughness Condition Rating
    - IRI



Performance – Washington Road Tahoe National Forest, CA

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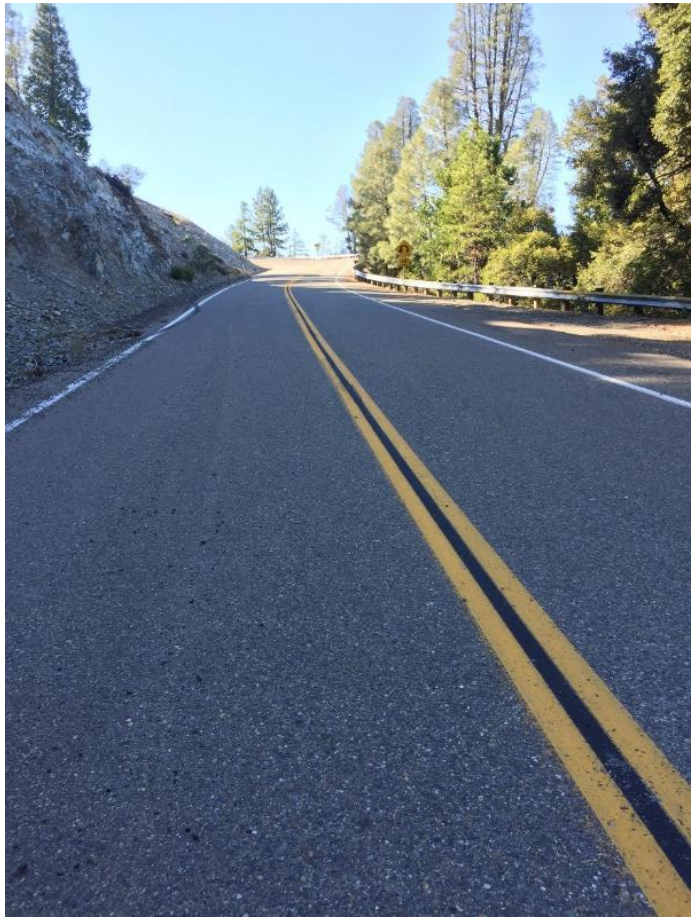
Federal Highway Administration

2009 – under construction



2019 – 10 years old

Performance – Ice House Road
El Dorado National Forest, CA

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Federal Highway Administration

22 years old

31 years old

Performance – Rocky Mountain National Park, CO

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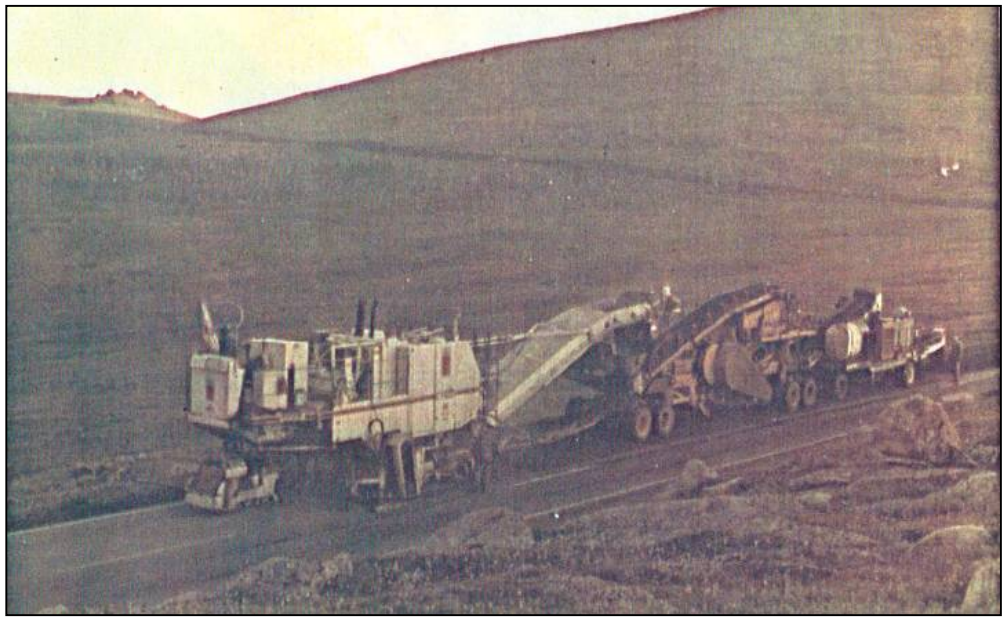
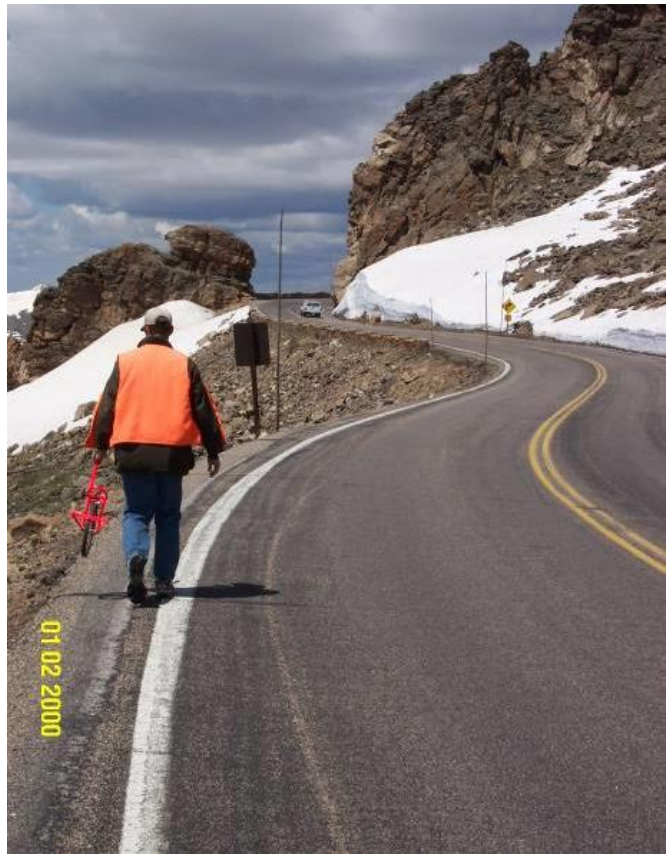
1982 CIR





After 26 years!

Outline

U.S. Department of Transportation
Federal Highway Administration

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Project/Recycling Technology Selection Criteria

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Federal Highway Administration

- Some Examples:
  - FLH
    - https://highways.dot.gov/federal-lands/specs
  - INDOT
    - https://www.in.gov/dot/div/contracts/design/Part%206/Chapter%2060 2%20-%20Project%20Categories%20and%20Pavement%20Types.pdf
  - NYSDOT
    - https://www.in.gov/dot/div/contracts/design/Part%206/Chapter%2060 2%20-%20Project%20Categories%20and%20Pavement%20Types.pdf
  - FHWA Tech Brief: Overview of Project Selection Guidelines for Cold In-place and Cold Central Plant Pavement Recycling
    - https://www.fhwa.dot.gov/pavement/asphalt/pubs/hif17042.pdf

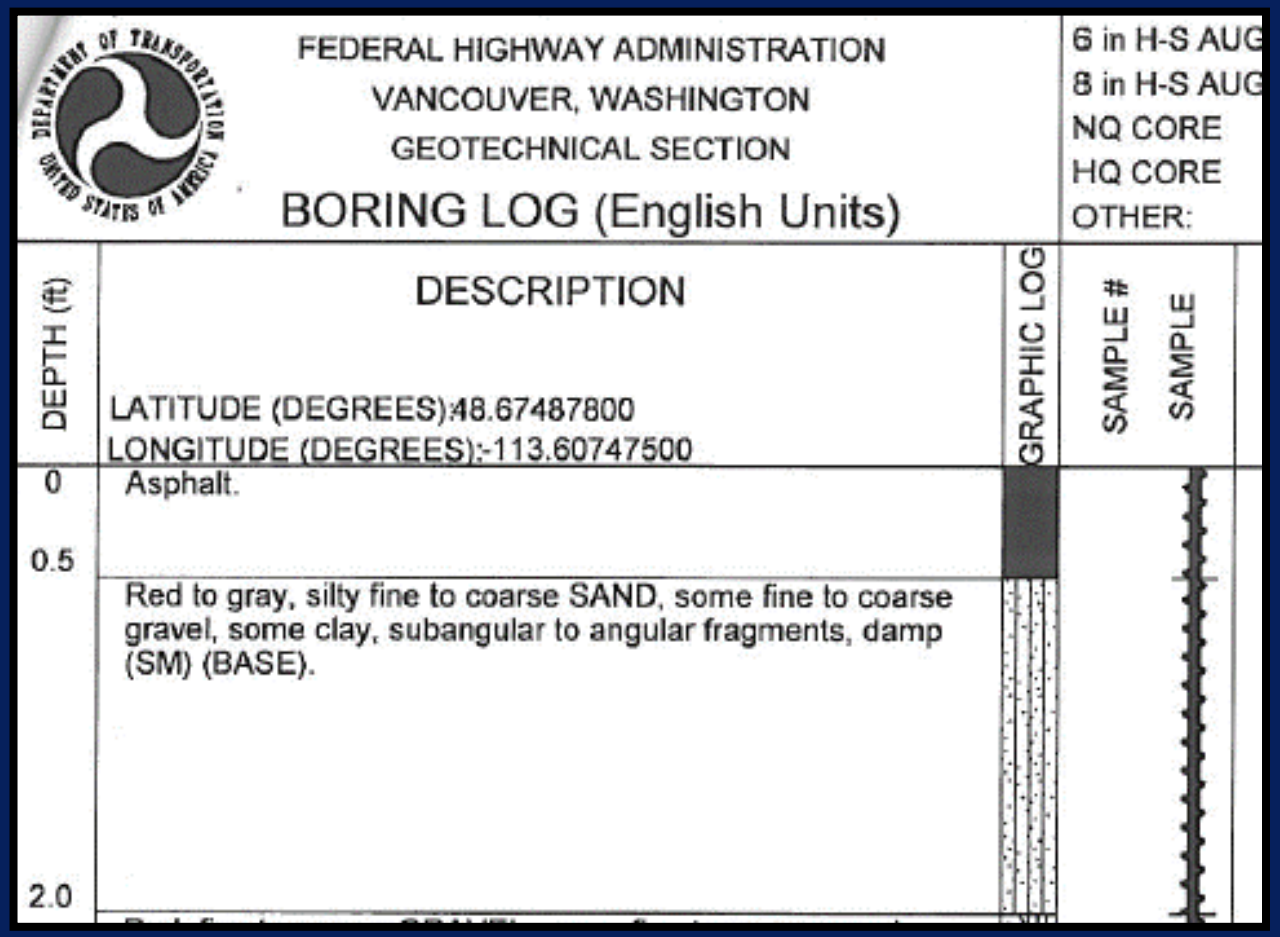
Project Selection: Possible Characteristics of a Good Candidate

- End of service life.
- Minor patching.
- Fatigue cracking.
- 3-inch depth minimum.

Project Selection: Possible Characteristics of a Poor Candidate

- Road geometry: grade and curves.
- Less than 3 inches.
- Geotextile in milling depth.
- Need to tie into existing structures.

Project Selection: Field Investigation



FEDERAL HIGHWAY ADMINISTRATION
VANCOUVER, WASHINGTON
GEOTECHNICAL SECTION

BORING LOG (English Units)

6 in H-S AUG
8 in H-S AUG
NQ CORE
HQ CORE
OTHER:

DEPTH (ft)	DESCRIPTION	GRAPHIC LOG	SAMPLE #	SAMPLE
	LATITUDE (DEGREES):48.67487800 LONGITUDE (DEGREES):-113.60747500			
0	Asphalt.			
0.5	Red to gray, silty fine to coarse SAND, some fine to coarse gravel, some clay, subangular to angular fragments, damp (SM) (BASE).			
2.0				

Average Distance between Borings	2674 feet
Average Thickness of Pavement	4.2 inches
Controlling Thickness	3.6 inches

Boring No.	Station	Distance Between Borings (ft)	Pavement Depth (in)
SG03-45	2059+70	2640	3.8
SG03-46	2086+10	2700	4
SG03-47	2113+10	2640	3.6
SG03-48	2139+50	2680	4.2
SG03-49	2166+30	2676	5
SG03-50	2193+06	2680	3.6
SG03-51	2219+86	2654	4.5
SG03-52	2246+40	2760	4
SG03-53	2274+00		5

INDOT Pavement Treatment Selection

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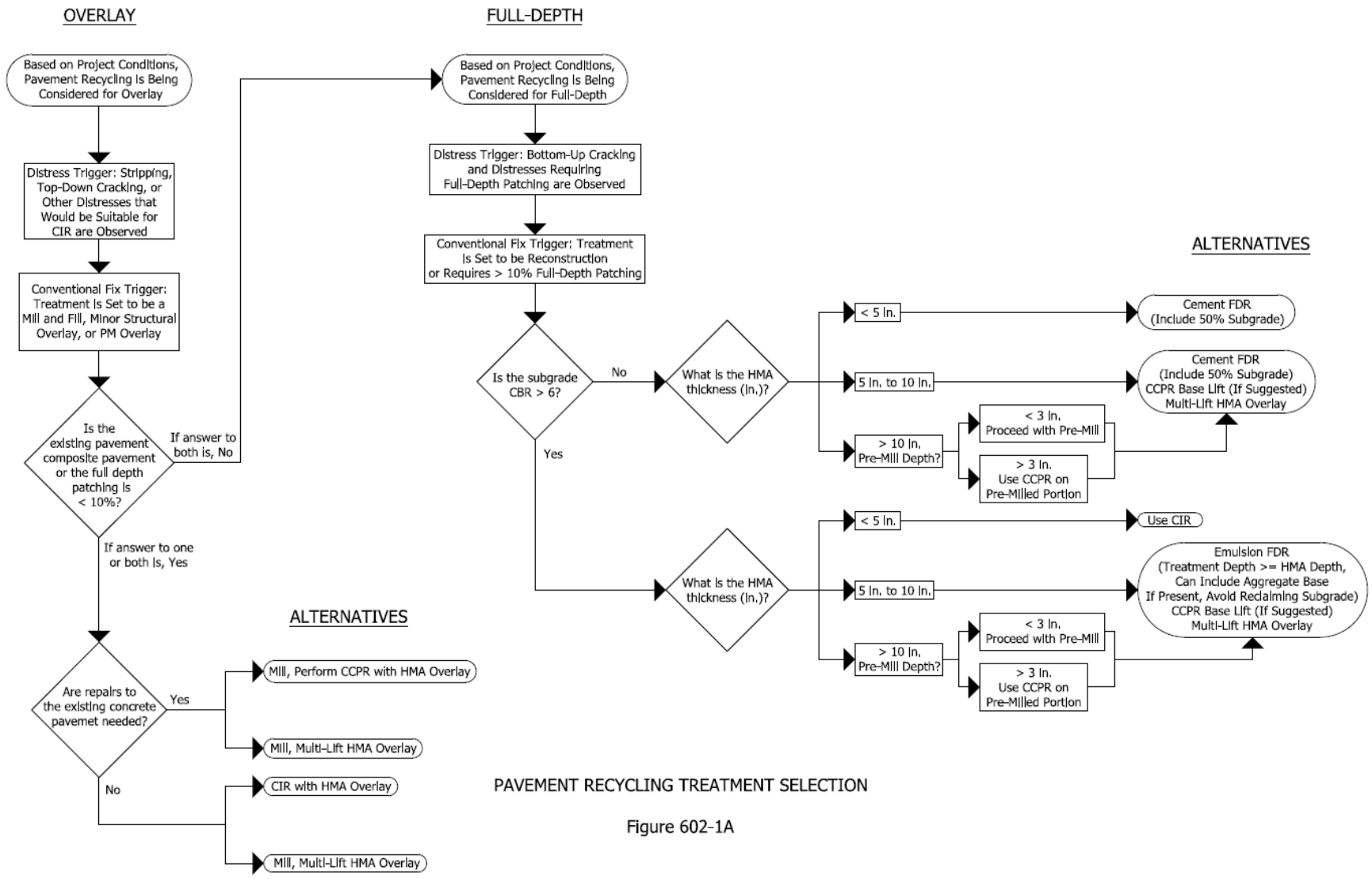

PAVEMENT RECYCLING TREATMENT SELECTION

Figure 602-1A

Source: Indiana DOT

https://www.in.gov/dot/div/contracts/design/Part%206/Chapter%20602%20-%20Project%20Categories%20and%20Pavement%20Types.pdf

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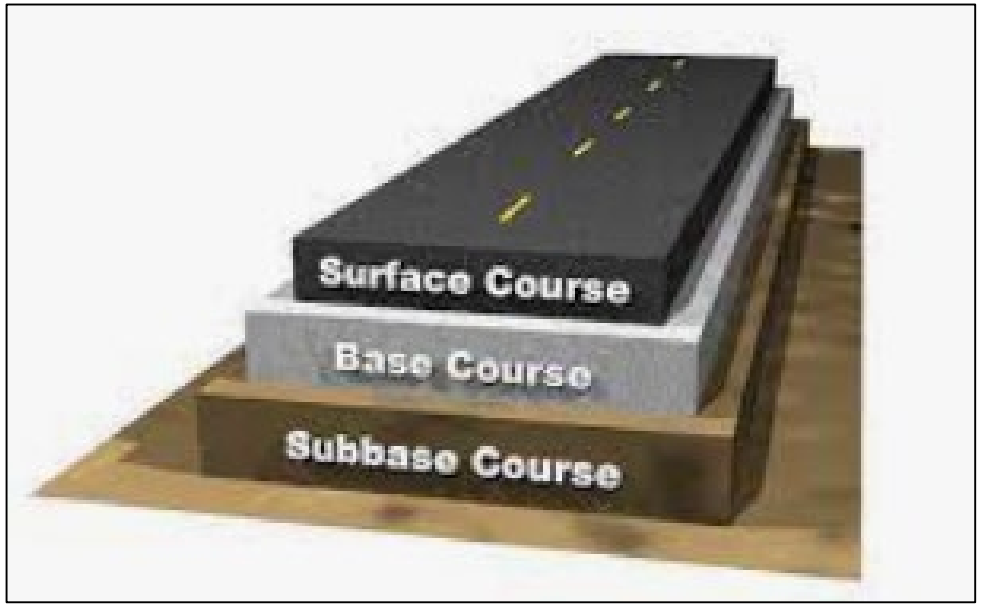

Structural Pavement Design

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- AASHTO 1993: FLH, NMDOT, SCDOT, VDOT (rehab)
- AASHTOWare Pavement™ ME Design: INDOT, NYSDOT, VDOT (new)

Item	FLH	INDOT	NMDOT	NYDOT	SCDOT	VDOT
CIR	0.28-0.30	75-100ksi	0.35	n/a[1]	n/a	0.35
CCPR	0.25-0.30	75-100ksi	0.35	n/a	n/a	0.35[2]
FDR AC	0.20-0.25	75-100ksi	0.30	n/a	n/a	0.25
FDR PC	0.15-0.22	75-100ksi	n/a	n/a	0.26	0.25

[1]NYSDOT typically very thick pavements, so no formal structural design is performed.
[2]VDOT used aggregate base thickness multiplied by 1.26 for CCPR in AASHTOWare Pavement™ ME Design.

CIR Requires a Riding Surface

Surface with:

- Asphalt pavement.
  - Use a tack coat.
- Double chip seal.

CIR Materials Selection – Binders & Active Fillers

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Item	FLH	INDOT	NMDOT	NYSDOT	VDOT
Binders	Engineered Emulsion	Emulsion	Engineered Emulsion	Emulsion, PM Emulsion, PG64S-22 Foamed Asphalt	Emulsion or Foamed Asphalt
Active Filler	Portland Cement or Lime Slurry	Portland Cement Allowed	Portland Cement or Lime	1% Portland Cement	Portland Cement

Terminology…binder, stabilizing agent, active fillers

CIR Mix Design

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	FLH	INDOT	NMDOT	NYSDOT	VDOT
Compactor	Gyratory-35	Gyratory-30	Gyratory-30	Gyratory-30	Marshall-75
Emulsion	Indirect Tensile Strength & TSR	Marshall Stability & Retained Stability, Raveling	Indirect Tensile Strength & TSR Coating, Raveling	Indirect Tensile Strength & TSR or Retained Marshall Stability	Marshall Stability & Retained Stability
Foamed	n/a	n/a	n/a	Indirect Tensile Strength & TSR or Retained Marshall Stability	Indirect Tensile Strength & TSR, Half-Life

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FDR *Asphalt* Materials Selection – Binders & Active Fillers

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	FLH	INDOT	NMDOT	VDOT
Binders	Emulsion or Foamed Asphalt	Emulsion	Foamed Asphalt	Emulsion or Foamed Asphalt
Active Filler	Portland Cement	Portland Cement Allowed	Portland Cement	Portland Cement, Lime
Top Size Material	<1.5”	2.0”	<3.0”	2.0”

Terminology…binder, stabilizing agent, active fillers

FDR *Asphalt* Mix Design

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	FLH	INDOT	NMDOT	VDOT
Compactor	Gyratory-35	Gyratory-30	Marshall-75	Marshall-75 or 30 Gyration
Emulsion	ITS & TSR	ITS Dry & Wet	n/a	Marshall Stability, MDR T180
Foamed	ITS & TSR Expansion Ratio & Half Life	n/a	ITS & TSR, MDR (T180)	ITS & TSR, Half-Life, MDR T180

FDR *Cement* Materials Selection – Binders & Active Fillers

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Item	FLH	INDOT	SCDOT	VDOT
Binders	Portland Cement	Portland Cement	Portland Cement	Portland Cement
Active Filler	Lime Occasional			Lime, Kiln Dust
Top Size Material	< 1.5”	< 2.0”	< 3.0”	< 2.0”

Terminology…binder, stabilizing agent, active fillers

FDR *Cement* Mix Design

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	FLH	INDOT	SCDOT	VDOT
Compactor	T134	T180	T99	T134
Cement	UCS (min and max), Freeze-Thaw Mass Loss	UCS (min and max)	UCS (%PC at 600psi)	UCS

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Quality Control & Acceptance

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6 Core Elements of a QA Program

Common Production QC Measurements

- Binder.
- Moisture.
- Gradation top size.
- Density.
- Thickness.
- Curing.

CIR & CCPR Curing & Opening to Traffic

Item	FLH	INDOT[1]	NMDOT	NYSDOT	VDOT
Traffic	0 for 2 hours	-	0 for 2 hours	-	0 for 2 hours
Moisture Content	≤ 2.5%	≤ 3.0%	≤ 3.0%	-	≤ 50% of optimum moisture content
Time	Cover within 14 days	≥ 3 days or 10 days without rainfall	≥ 3 days	Emulsion ≥ 10 days; Foamed Asphalt ≥ 3 days	-

[1]**Greater than 3 days and less than 3.0% moisture or cured 10 days without rainfall.**

NCHRP Research Projects

U.S. Department of Transportation
Federal Highway Administration

- NCHRP 09-62, Report 960 at: https://nap.nationalacademies.org/download/25971

NCHRP 09-62 [Completed]

Rapid Tests and Specifications for Construction of Asphalt-Treated Cold Recycled Pavements

Project Data	
Funds:	$999,737
Research Agency:	Virginia Transportation Research Council
Principal Investigator:	Brian Diefenderfer
Effective Date:	6/1/2017
Completion Date:	8/31/2022
Comments:	Publication pending

- Objective: The objectives of this research are to develop (1) time-critical tests for asphalt-treated CIR, FDR, and CCPR materials and (2) a guide specification using these tests for process control and product acceptance that provides the agency with a basis for determining when the pavement can be opened to traffic and surfaced.

https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4190

The use of an NCHRP Report is not a Federal requirement.

NCHRP Project 09-62 Phase III – Field Trials MnROAD

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Federal Highway Administration

Images Source: Adam Hand

NCHRP Final Test Suggestions

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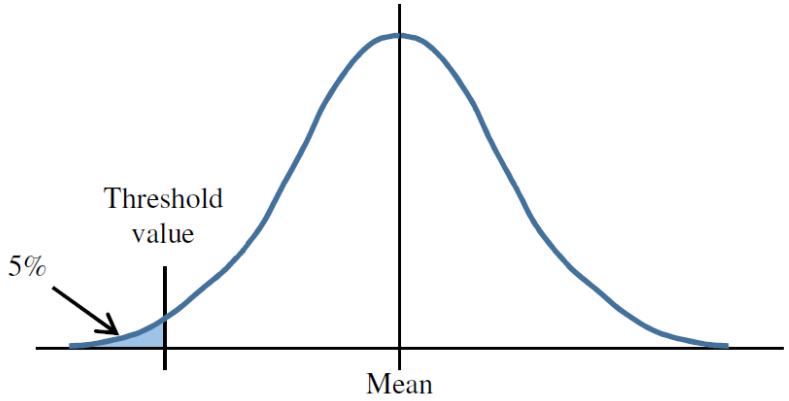
- Short Pin Raveling Test (SPRT)
  - Blows & Torque
- Long Pin Shear Test (LPST)
  - Blows and Torque
- Data Set



Suggested Tests	Properties	Mean	Pooled σ	Threshold Value (Average of 3 Tests)
Short-Pin Raveling Test (SPRT)	Number of Blows	8.4	0.8	7.1
	Torque, ft-lb	24.3	2.5	20.2
Long-Pin Shear Test (LPRT)	Number of Blows	22.8	2.1	19.3
	Torque, ft-lb	76.4	8.2	62.9

https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4190

NCHRP Research Projects

U.S. Department of Transportation
Federal Highway Administration

- NCHRP 14-43, Web-only Document 363 at: https://www.trb.org/Publications/Blurbs/182965.aspx

NCHRP 14-43 [Final]

Construction Guide Specifications for Cold Central Plant Recycling and Cold In-Place Recycling

Project Data	
Funds:	$250,000
Research Agency:	National Center for Asphalt Technology
Principal Investigator:	Benjamin Bowers
Effective Date:	5/26/2020
Completion Date:	8/31/2022
Comments:	Report Published as NCHRP Web-Only-Document 363

- Objective: to produce proposed AASHTO Construction Guide Specifications for the application of CCPR and CIR in the standard five-part AASHTO format with supporting commentary. The specifications shall include plans for quality assurance and agree with current provisional material specifications and mix design practices for these treatments. The specifications shall enable specifying agencies to tailor their own specifications to the local conditions and environments.

https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4755

The use of an NCHRP Report is not a Federal requirement.

HIR

- Surface Recycling, Surface Repaving, or Remixing
- Rapid opening to traffic, new surface

U.S. Department of Transportation
Federal Highway Administration

Outline

U.S. Department of Transportation
Federal Highway Administration

- Introduction and Background
- Performance, Sustainability, Cost
- Project Selection
- Pavement and Mix Designs
- Production
- Summary

Suggested Practices from Participating Agencies

U.S. Department of Transportation
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- Pre-Construction
  - Detailed treatment selection guide
  - Regularly updated specifications
  - Adequate site investigation
  - Representative samples
  - Pre-construction meetings (all SH 4-8 hours)
- Mix Design
  - Accredited labs
  - Leveraging engineered emulsions
- Production & Acceptance
  - Requiring QC Plans
  - Control or test strips for density
  - Proof rolling requirement
  - On-site technical representative
  - Monitor yield daily
  - Maintenance/traffic control while curing
  - Pay for binder as separate item
- Programmatic
  - Post-project/season stakeholder meetings
  - Collecting performance data

Lessons Learned from Participating Agencies

U.S. Department of Transportation
Federal Highway Administration

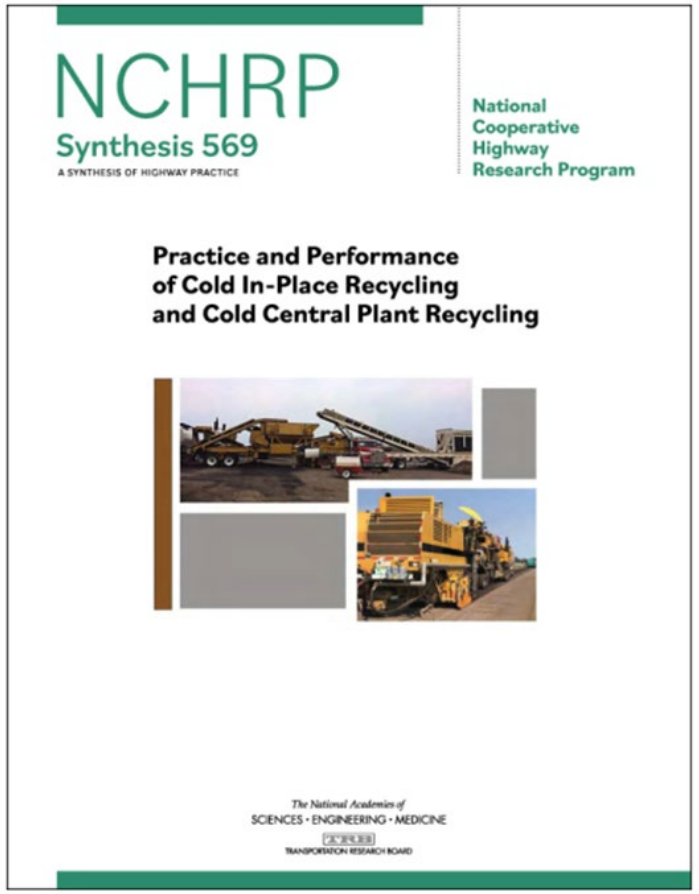
- Use large enough minimum project sizes
- Without detailed site investigation variability can create issues
- Adequate drainage is essential
- Don’t overlook geometric constraints (underpasses, drainage inlets, guardrail height, etc.)
- If significant changes in cross section (subgrade, mc, thickness), may require more than one mix design
- If correcting geometry (grades/cross slopes) be sure adequate recycled layer thickness
- Leave adequate pavement structure in-place
  - Do not include aggregate base in CIR
- Require mix designs and QCPs 30 days prior to production
- Recognize recycled layer “fluffs”
- In high moisture, portland cement helps with strength

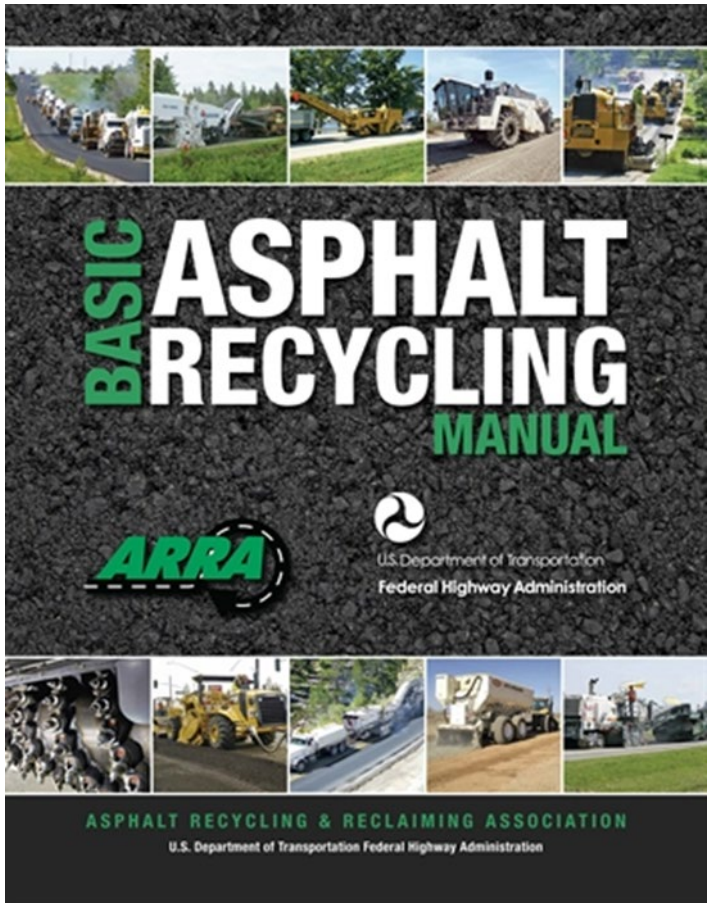
Lessons Learned from Participating Agencies

U.S. Department of Transportation
Federal Highway Administration

- Night work, early season, cool temps, CIR emulsion breaking
- Change milling speed, moisture & temperature affect gradation & density
- Calibrate equipment
- Keep rollers back from paver on CIR, not like HMA
- Contractor and inspector experience with new technologies important
- HMA tech ≠ CIR tech
- Tack coats are helpful
- Post-project/season stakeholder meetings

References






TechBrief

The Asphalt Pavement Technology Program is an integrated, national effort to improve the long-term performance and cost effectiveness of asphalt pavements. Managed by the Federal Highway Administration through partnerships with State highway agencies, industry, and academia, the program's primary goals are to reduce congestion, improve safety, and foster technology innovation. The program was established to develop and implement guidelines, methods, procedures, and other tools for use in asphalt pavement materials selection, mixture design, testing, construction, and quality control.

U.S. Department of Transportation
Federal Highway Administration

Office of Asset Management, Pavements, and Construction

FHWA-HIF-17-042

February 2018

Overview of Project Selection Guidelines for Cold In-place and Cold Central Plant Pavement Recycling

This Technical Brief provides project selection guidelines for the cold recycling techniques of cold in-place and cold central plant recycling. The Tech Brief intends to aid the user in properly selecting candidate projects for using cold pavement recycling. Significant improvements in cold recycling technologies have been made since the 2000s, including improvements in engineering, construction equipment, and test methods, together with improved mix designs, resulting in improved reliability of performance of the final product.

Introduction

Various in-place recycling techniques have been used to rehabilitate and maintain pavements in the United States since the 1930s. Two events of the 1970s rekindled interest in asphalt recycling: the petroleum crisis and the development of large-scale cold planing equipment with easily adjustable milling teeth.

In recent years, the economics and supply of petroleum and high quality natural aggregates have increased the need for cost-effective alternatives to virgin paving materials. Two in-place recycling alternatives include cold in-place recycling (CIR) and cold central plant recycling (CCPR). These methods provide owner agencies with cost effective and sustainable methods to repair their aging asphalt pavements. When applying the **right treatment** to the **right road** at the **right time**, and when properly designed, specified and constructed, these methods can result in cost savings of 30 to 50 percent compared to conventional asphalt operations, thus allowing for more miles of improved roadways from the associated cost savings. In addition, CIR and CCPR have been shown to accelerate project delivery and mitigate construction traffic congestion while including improvements in the overall sustainability of operations.

In spite of economically and environmentally effective technologies being available for decades, many owner agencies

1

References

U.S. Department of Transportation
Federal Highway Administration

FHWA website at: https://www.fhwa.dot.gov/pavement/recycling/apiprt.cfm

Tech Brief.
NHI 2-day training.
Just in time videos.
Checklist series.

Thank You

Q & A

Adam Hand
University of Nevada Reno
adamhand@unr.edu

Tim Aschenbrener
Federal Highway Administration
Timothy.aschenbrener@dot.gov

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Federal Highway Administration