

PENNDOT RESEARCH AND INNOVATIONS

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Pennsylvania
Department of Transportation

PENNDOT RESEARCH AND INNOVATIONS



STIC Innovation on Fuel Resistant (FR) Highly Modified Asphalt Binder for Amish Buggy Routes



STIC Innovation on Cold Central Plant Recycling (CCPR)



Recycled Plastics in Asphalt Research Project and Laid Pilot Projects



SMA with Highly Modified Asphalt (HiMA) Efforts and Research



Binder Rich Intermediate Course (BRIC), Stress Absorbing Membrane Interlayer (SAMI) Potential Research.



Existing Products Utilized in Projects from Previous Research

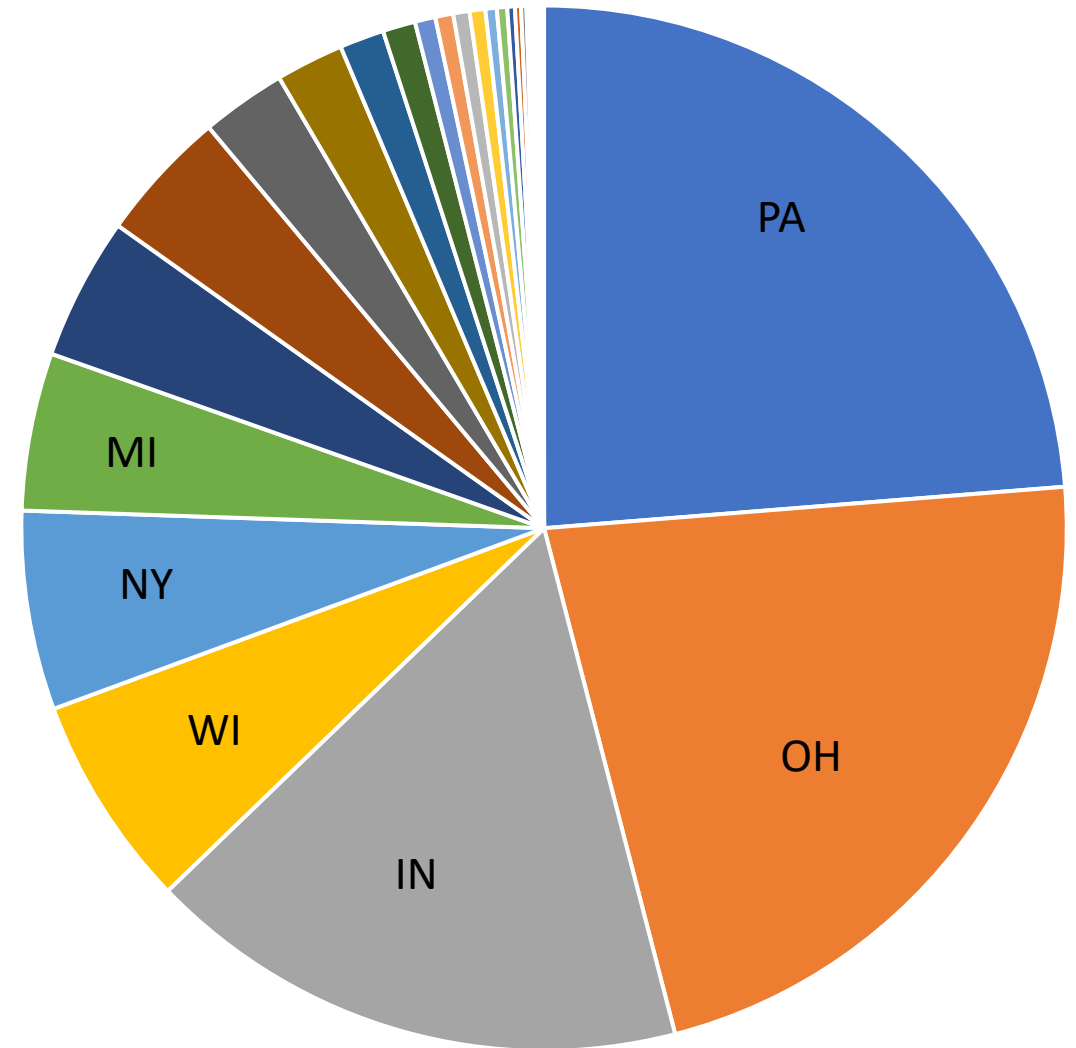
FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER

PA has the largest population of Amish in the U.S.

Nearly 90,000 Amish across the commonwealth

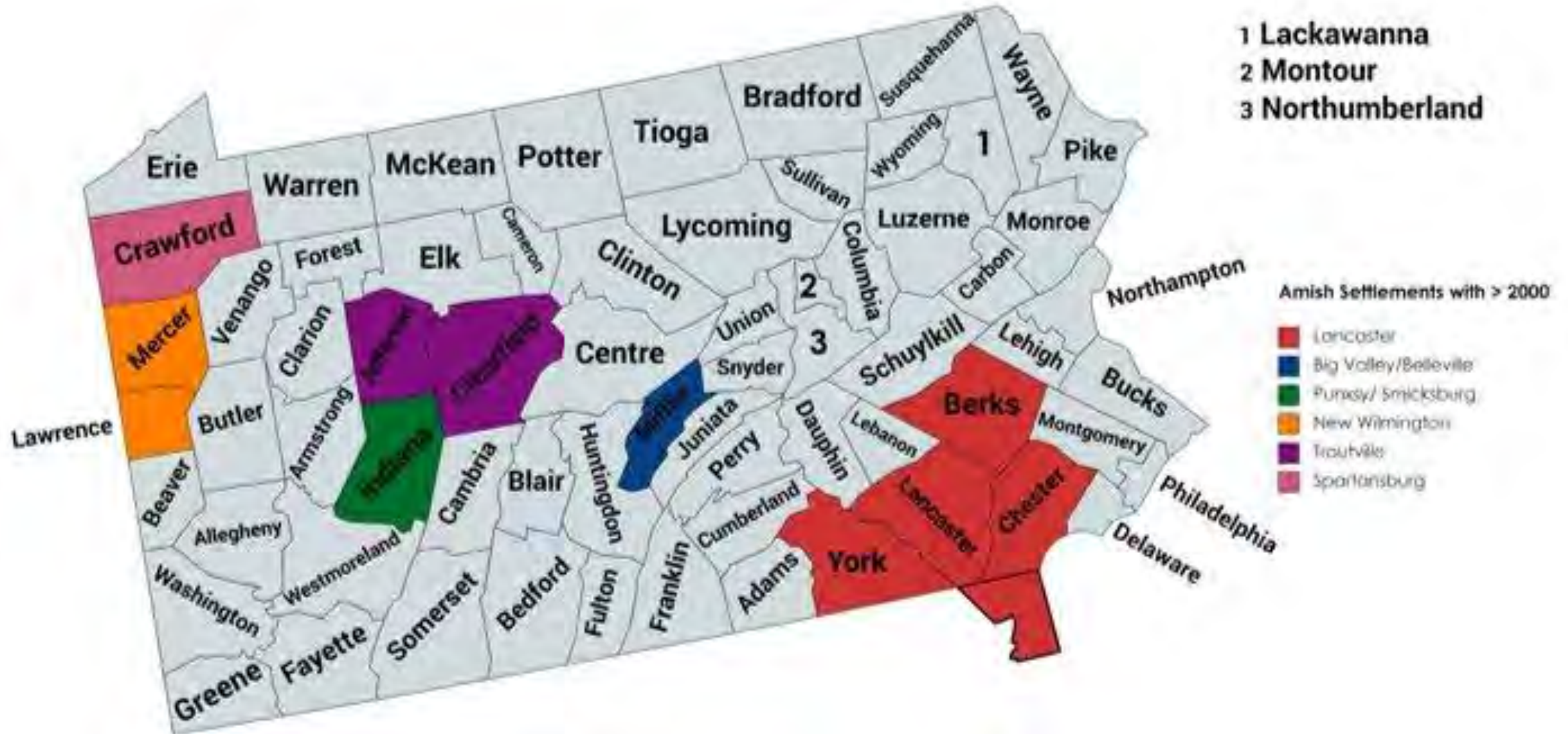
- Pennsylvania
- Ohio
- Indiana
- Wisconsin
- New York
- Michigan
- Missouri
- Kentucky
- Iowa
- Illinois
- Minnesota
- Tennessee
- Kansas
- Virginia
- Delaware
- Maryland
- Montana
- Maine
- Colorado
- Oklahoma
- West Virginia
- Nebraska
- Wyoming
- North Carolina
- Arkansas
- Mississippi
- South Dakota
- Idaho
- Vermont
- Florida
- Texas
- New Mexico

Amish Population by U.S. State



Source: "Amish Population, 2023." Young Center for Anabaptist and Pietist Studies, Elizabethtown College. <http://groups.etown.edu/amishstudies/statistics/population-2023/>

FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER



FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER



Initially developed for airports



Proven technology for repairs in other DOTs for Amish Horse and Buggy Routes



Pennsylvania State Transportation Innovation Council (STIC) Initiative



Image: Jim Halverson

FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER



Image: Don Burke

Left: Both are new, one has a hard overlay welded on the toe and caulk for less wear on paved roads.

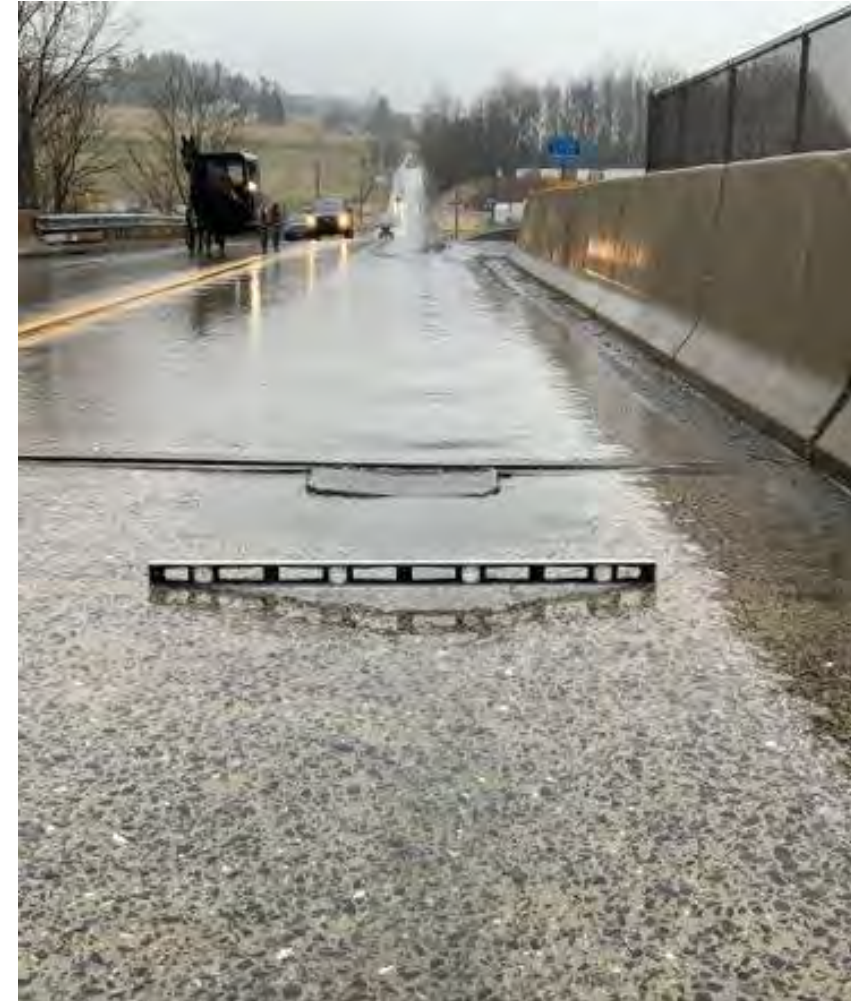


Image: Dale Good

Right: Damage from horse and buggy traffic.

FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER



Requiring Alternate Horseshoes not perceived well in all Amish communities



Mill and Pave Repair



Spot Patching Repair



Chip Seal in Horse Tracks



Service Life of Repairs
Varies

Franklin Co.: 1.5 – 2 years

Lancaster Co.: 2.5 – 3 years



Image: PennDOT Lancaster County

FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER

Section 9000-XXXX |

SUPERPAVE MIXTURE DESIGN WITH FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT, PG 76E-22 (FR), CONSTRUCTION OF PLANT-MIXED WMA WEARING COURSE

I. DESCRIPTION—This work is construction of a 9.5mm or 12.5mm Superpave Asphalt Wearing Course, as specified, on a prepared surface using Fuel Resistant (FR) High Polymer Modified Asphalt Binder.

II. MATERIAL—Section 413.2 with the following modifications:

(a) **Asphalt Material.** Replace Section 419.2(a)1., first paragraph, with the following:

Virgin Mix. Furnish a Fuel Resistant High Polymer Modified Asphalt, PG 76E-22FR binder. The binder shall conform to the requirements of AASHTO M 332 Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test as revised in Table A. Obtain material from a source listed in Bulletin 15 approved to furnish PG 64E-22 conforming to AASHTO M 332 except as revised in Bulletin 25. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b) 1. Provide the Representative a copy of a Bill of Lading for asphalt material on the first day of paving and when the batch number changes. Do not use Reclaimed Asphalt Pavement (RAP) or Recycled Asphalt Shingles (RAS) in the Wearing Course.

(b) **JMF Design:**

1. Design JMF at 50 gyrations.
2. Design air voids (V_a) at 2.5%.
3. Binder test for weight loss by fuel immersion: Maximum weight loss 1.5%.
 - a. Prepare three test specimens meeting mix design requirements at optimum binder content and $2.5 \pm 0.7\%$ air voids
 - b. Dry specimens under a fan at room temperature (68°F - 80°F) for 24 hours
 - c. Immerse the sample completely in kerosene meeting ASTM D3699 at room temperature
 - d. (68°F - 80°F) for 2 minutes \pm 30 seconds.
 - e. Remove the sample and surface dry it with a clean paper towel.
 - f. Weigh the sample to the nearest 0.1 grams and record this value as weight "A".
 - g. Immerse the sample in the kerosene for 24 hours \pm 10 minutes.
 - h. Towel dry the sample and place under a fan at room temperature for 24 hours \pm 10 minutes.
 - i. Weigh the sample to the nearest 0.1 grams and record this value as weight "B".
 - j. Calculate the weight of loss by fuel immersion:

Section 9000-XXXX

PERFORMANCE RELATED TEST DATA AND THE DELTA Tc (ΔT_c) PARAMETER

I. DESCRIPTION—This work is performing additional asphalt binder testing on the asphalt binder used in the indicated control section(s) and on the Fuel Resistant (FR) High Polymer Modified Asphalt Binder, PG 76E-22FR used in the indicated experimental section and performing additional asphalt mixture performance related testing on the indicated control section(s) mixture and on the indicated (FR) High Polymer Modified Asphalt Binder experimental section mixture.

II. MATERIAL

1. Asphalt Material Characterization.

Coordinate with the PG asphalt binder supplier to characterize and provide the Delta Tc (ΔT_c) Parameter at 40 h of AASHTO R 28 PAV conditioning in the Certificate of Analysis for the certified lot or batch of asphalt binder furnished for use in the control section(s) mixture and for use in the (FR) High Polymer Modified Asphalt Binder experimental section mixture. The (ΔT_c) Parameter shall be evaluated according to AASHTO R 118, Characterizing the Relaxation of Asphalt Binders Using the Delta Tc (ΔT_c) Parameter.

2. Asphalt Mixture Performance-Related Testing.

(a) **General.** Designate a laboratory or laboratories that are AASHTO Resource accredited to perform specified asphalt mixture performance related tests on laboratory-prepared asphalt mixture samples representing the control section(s) and the (FR) High Polymer Modified Asphalt Binder experimental section. Notify the District Materials Engineer/Manager at least 48 hours before preparation of any performance related test specimens. Submit all performance related test results to the District Materials Engineer/Manager immediately after test completion.

Provide the laboratory-prepared performance related test specimens to the laboratory designated by the contractor. Prepare all performance related test specimens from laboratory-prepared asphalt mixture. Do not prepare performance related test specimens from plant-produced asphalt mixtures.

FUEL RESISTANT HIGH POLYMER MODIFIED ASPHALT BINDER



Non-proprietary specification developed internally and with assistance of industry.



Currently coordinating with Districts for a pilot project in Pennsylvania.



Ideally compare side by side with other material(s) to provide future insight to cost versus benefit claims.



Specification will be again critiqued during and after construction, then revised as necessary.



Image: securebusinessadvisors.co.uk

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS

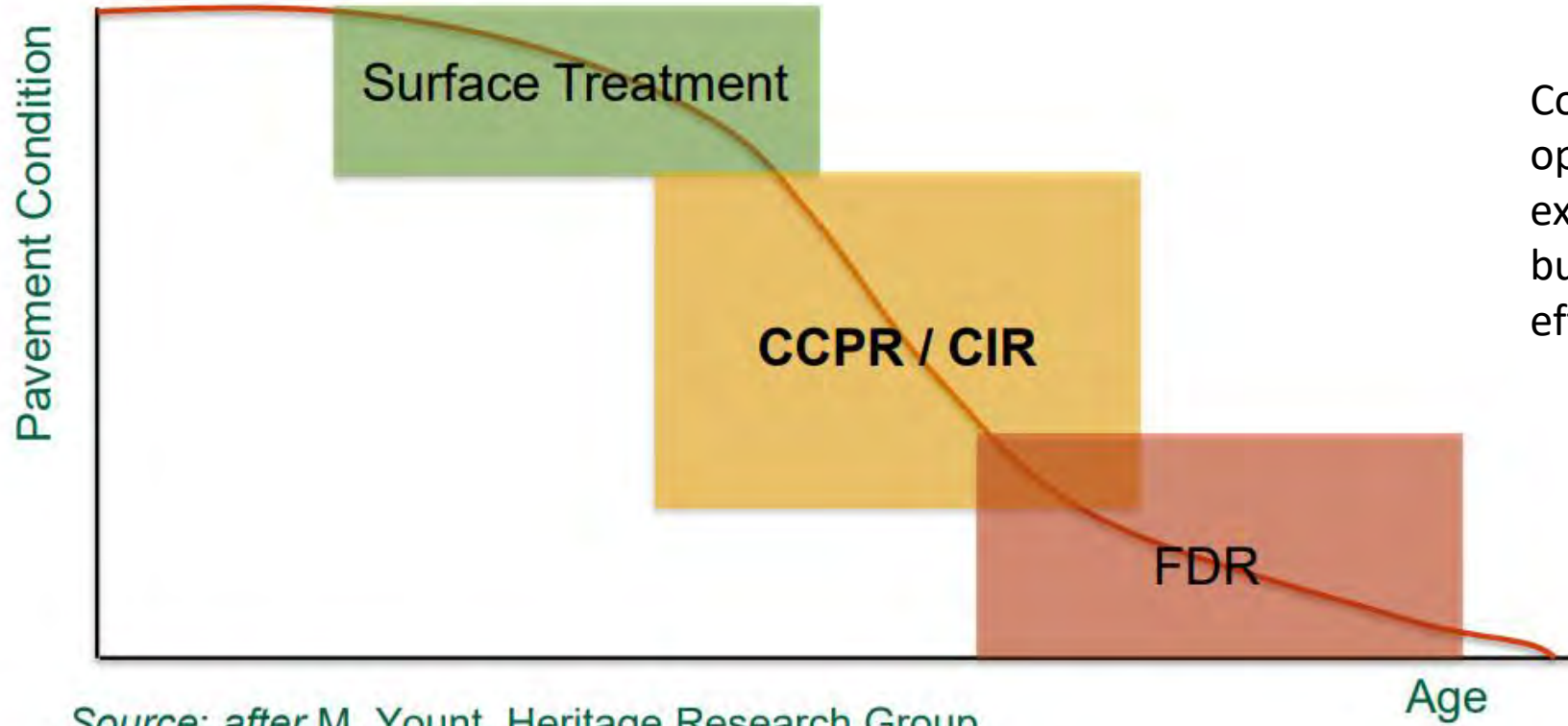
Cold Central Plant Recycling (CCPR) is the process in which the asphalt recycling takes place at a central location using a mobile cold mix plant (stationary, not part of a train).

PennDOT currently allows this process for base courses between 3 and 5 inches.



Image: roadresource.org

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS



Cold Recycling can be considered an option when roadway distresses extend beyond surface treatments, but it still requires a stable base to be effective.

Publication 408 contains standard specifications for both practices.

The CCPR specification refers back to the CIP specification.

SECTION 342—CENTRAL PLANT MIX COLD RECYCLED ASPHALT BASE COURSE

342.1 DESCRIPTION—This work is the construction of a central plant mixed cold recycled asphalt base course (CPMCRABC), using a combination of RAP, RAM, virgin aggregates, or cement, mixed with an emulsified or foamed asphalt stabilizing agent in a continuous or batch type mixer.

342.2 MATERIAL—Section 341.2 and as follows:

(a) Stockpiling. Store reclaimed material in a manner that preserves its quality and suitability. Separate different types of RAP to prevent contamination. Build stockpiles in horizontal layers to minimize segregation. Keep stockpile height to a maximum of 10 feet.

342.3 CONSTRUCTION—

(a) Equipment. Provide equipment to produce CPMCRABC as follows:

1. Provide a central plant consisting of a RAP feed hopper, conveyor belts, twin shaft pugmill, metered emulsified asphalt, or foamed asphalt additive, metered cement additive, and water additive systems, with pumps and spray bars. Other equipment may include additive storage tanks, belt scales, a stacker belt conveyor, and a storage bin. Provide a screening/crushing unit if the maximum size of RAP cannot be controlled otherwise.

Provide equipment capable of mixing reclaimed material and asphalt material into a homogeneous mixture without stripping the asphalt material. Provide a continuous-flow or batch-type mixer accepted by the Representative and equipped with batching or metering devices to measure the specified quantities of the materials. Equip the foamed asphalt system with a test nozzle to allow field samples of foamed asphalt. Equip hot asphalt supply tankers for foamed asphalt stabilized applications, with gauges that continuously display the temperature of the asphalt. Equip the foamed asphalt system to accurately and uniformly inject water into hot asphalt binder, and uniformly mix foamed asphalt, RAP material, and water, to meet mix design requirements.

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS

Publication 242 contains current project selection criteria for the usage of Cold-In-Place and Cold Central Plant Recycled Base Courses.

This STIC initiative is an effort to extend the usability of this technology beyond 15,000 **ADT and expand it's potential.**

RAP is in abundance in urban areas, where traffic volumes are the highest.

1. ADT Criteria:

**TABLE 5.7
ADT CRITERIA**

ADT VOLUME	COLD RECYCLING OPTION
1,000 and less	Provide a surface treatment (double application) as a minimum for wearing course.
1,001 to 3,000	Provide a Superpave wearing course or cold mix wearing course (FB modified, FB-2, or FB-1).
3,001 to 10,000	Provide a Superpave wearing course.
10,001 to 15,000	If daily ESALs are less than 200, provide a Superpave wearing course and binder course.
More than 15,000	Do not use.

Projects carrying significantly heavy truck traffic (i.e., 200 or more daily ESALs) should not be selected for cold recycling.

2. The existing road must have at least 2 inches of asphalt material. Use 1 inch of underlying untreated reclaimed aggregate material (RAM) or add 1 inch of virgin aggregate during the recycling process to achieve the 3 inch minimum thickness. Do not specify the milling cut depth below the bottom of the existing asphalt pavement unless the underlying material is recyclable. If the RAM consists of aggregates larger than 2 inches (such as some native stone bases) or excessive soils, it cannot be appropriately recycled using these specifications and procedures. Department guidelines and specifications for Full Depth Reclamation are provided in [Section 5.15](#); Publication 408, *Specifications*, Section 344; and Publication 27, *Asphalt Concrete Mixtures, Design Procedures, and Specifications for Special Asphalt Mixtures* (Bulletin 27), Chapter 2, Section 7: Full Depth Reclamation (Using Asphalt Stabilization Process).

3. If the existing road has deteriorated due to poor drainage conditions, do not attempt cold recycling.

4. Only select projects where traffic can be controlled or detoured during base construction and curing period.

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS

Virginia DOT I-64 utilized full depth reclamation (FDR) and cold central plant recycling (CCPR) to complete the reconstruction of the existing pavement as well as the roadway widening work.

Claiming over \$10 million in savings.



Image: forconstructionpros.com

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS



Image: clipart.com

Aggregate Gradation

Addition of Aggregate

Stabilizing Agents (emulsified or foamed)

Temperature Restrictions

Effective Design Structural Coefficient

Performance Criteria

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS

Uses excess RAP being stockpiled in urban areas.

Cost-effective solution to structural distresses.

No heat at the plant results in a lower carbon footprint.



Image: hrcurator.com

COLD CENTRAL PLANT RECYCLING (CCPR) ON HIGH VOLUME ROADS

Specification developed and currently in industry review.

Seeking a pilot project, with selection criteria sent to Districts.

Ideally large project quantity to increase cost effectiveness of mobilization.

Specification will be again critiqued during and after construction, then revised as necessary.



Image: dreamstime.com

RECYCLED PLASTICS IN ASPHALT

PennDOT Strategic Recycling Program (SRP) Research and Ridley Creek Pilot Project.

Penn State University Research and Testing

Additional Pilot Projects















SYMBOL	DESCRIPTION	
 PETE	Clear tough plastic such as soft drink, juice and water bottles.	
 HDPE	Common white or colored plastic such as milk containers and shampoo bottles.	
 V	Hard rigid clear plastic such as cordial bottles.	
 LDPE	Soft flexible plastic e.g. squeezable bottles such as sauce bottles.	
 PP	Hard but flexible plastic such as microwave ware, takeaway containers, some yogurt/ice cream/jam containers, hinged lunch boxes.	
 PS	Rigid, brittle plastic such as small tubs and margarine/butter containers.	
 OTHER	All other plastics, including acrylic and nylon. Examples include some sports drink bottles, sunglasses, large water cooler bottles.	

Image: asphaltpavement.org

RECYCLED PLASTICS IN ASPHALT

Ridley Creek State Park Roadway Reconstruction

Full depth reclamation

No. 2A Stone

Base Course

1 mile Wearing Course (30% RAP)

½ mile Wearing Course (Recycled
Plastic & 30% RAP)

New Shoulders

Drainage Repairs

Culverts & Pipe Crossings

Ditches

Channel Stabilization



Image: David Sledziewski

RECYCLED PLASTICS IN ASPHALT

PILOT PROJECTS OVER APPROX. PAST 5 YEARS

- Sandy Flash Drive South, Ridley Creek State Park, District 6, Delaware County, PA (almost 16 miles north of Philadelphia)
- SR 2037, District 6, Delaware County, PA
- SR 3017, District 8, Lancaster County, PA
- SR 0051, District 11, Allegheny County, PA

RECYCLED PLASTICS IN ASPHALT

- Collect Video Log Van Data from Pilot Projects
- Penn State University Research Project anticipated Publishing in 2026



SMA WITH HIGHLY MODIFIED ASPHALT (HiMA)

The image is a screenshot of the Federal Highway Administration's Center for Accelerating Innovation website. At the top, the FHWA logo and name are on the left, and navigation links for 'About', 'Programs', 'Resources', 'Briefing Room', 'Contact', and 'Search FHWA' are on the right. Social media icons for Facebook, YouTube, Twitter, LinkedIn, and Instagram are also present. Below the header is a large banner with the text 'Center for Accelerating Innovation' and a search bar. A breadcrumb trail reads 'FHWA Home / Accelerating Innovation / AID Demonstration'. A horizontal menu contains links for 'CAI Home', 'Every Day Counts', 'STIC Network', 'AID Demonstration' (which is highlighted), 'AMR Program', and 'Resources'. The main content area features a large image of a bridge under construction with the text 'AID Demo Accelerated Innovation Deployment'. At the bottom, three blue boxes with icons and text provide navigation: 'Find Proven Innovations Explore innovations >>', 'Learn from Others Explore success stories >>', and 'Fund Innovation Deployment Explore funding opportunities >>'.

Image: fhwa.dot.gov/innovation/grants/

SMA WITH HIGHLY MODIFIED ASPHALT (HiMA)

Associated Items

Item Number	Unit of Measure	Item Description
9000-0008	SY	STONE MATRIX ASPHALT MIXTURE DESIGN, WEARING COURSE, RPS PG 76E-28HP, LTS ACCEPTANCE 9.5MM MIX, 2" DEPTH, SRL-E

Header

Provision Body

DESCRIPTION - This work is construction of Stone Matrix Asphalt Wearing Course on a prepared surface using Highly Polymer Modified Asphalt Binder.

MATERIAL - Section 419.2 with the following modifications:

(a) Asphalt Material. Add the following:

Furnish a Highly Modified Asphalt (HiMA) binder. HiMA binder to conform to the requirements of AASHTO M 332 Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test as revised in Table PGHP. Obtain material from a source listed in Bulletin 15

Utilize in SMA Mixture

Reduce Rutting Potential

Increase Resilient Modulus

Increase Cracking Resistance

SMA WITH HIGHLY MODIFIED ASPHALT (HiMA)

FHWA SPONSORED RESEARCH PROJECTS

- ECMS #88579 – Interstate 80, Section B42, Clearfield County, Engineering District 2-0
- ECMS #23478 – SR 219, Section 047, Somerset County, Engineering District 9-0
- ECMS #74454 – Interstate 376, Section A79, Allegheny County, Engineering District 11-0
- ECMS #72807 – Interstate 78, Section 22M, Berks County, Engineering District 5-0

ADDITIONAL PILOT PROJECTS

- ECMS #112298 – Interstate 476, Section IMP, Delaware County, Engineering District 6-0
- ECMS #112299 – Interstate 76 Section IMP, Philadelphia County, Engineering District 6-0

SMA WITH HIGHLY MODIFIED ASPHALT (HiMA)

Preliminary PG 76E-28 Storage and Handling Recommendations:

- To minimize further viscosity drift on storage, the binder should be stored at 315-325F max or less with continuous agitation recommended.
- Material must be used within 72 hours of shipping date to avoid gelling in the tank due to high polymer content.
- A mixing and compaction temperature of +5-10F from what is recommended for a PG 64E-22/PG 76-22 binder should be sufficient.



Image: admasphaltplants.com

SMA WITH HIGHLY MODIFIED ASPHALT (HiMA)



MAIN CONCERN
WITH INITIAL HiMA
RESEARCH WAS
COST/BENEFIT RATIO.



DOCUMENT AND
SHARE BEST
CONSTRUCTION
PRACTICES.



MONITOR PROJECT
CONSTRUCTION
COMPLETION AND
SUBSEQUENT
PERFORMANCE.



EXAMINE POTENTIAL
FOR APPLICATIONS IN
OTHER MIX DESIGNS.



Image: rootedinrights.org

POTENTIAL FUTURE FOCUS TOPICS

INTERLAYERS

- Binder Rich Intermediate Course (BRIC)
- Stress Absorbing Membrane Interlayer (SAMI)
- Reflective Crack Relief Interlayer (RCRI)
- Similar but slightly different.
- Concept in use in other states, such as our neighbor, New Jersey.

EXISTING PRODUCTS UTILIZED IN PROJECTS FROM PREVIOUS RESEARCH

- **Match new staff with “old”** research.
- Crumb Rubber.
- Thin layers when the application is right.
- Fiber reinforced asphalt.
- **And others...**

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