History, Performance and Benefits of Cold Recycling

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Cold In-Place Recycling (CIR) involves milling the existing asphalt surfacing to a specified depth, sizing the milled material, adding various additives (emulsion, foam, lime slurry, cement), mixing the RAP and additives, laying and compacting the recycled material.
Pavement Management

- Cold Planing
- Hot In-Place Recycling
- Cold Recycling
- Full Depth Reclamation

Pavement Condition Index (PCI)

Time/Traffic
# Recycling and Reclaiming Strategies and Their Effects

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<tr>
<th>M&amp;R Category</th>
<th>Strategy</th>
<th>Method:</th>
<th>CP</th>
<th>HIR</th>
<th>CR</th>
<th>FDR</th>
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- With HMA Overlay
- CR: CIR & CCPR
First Attempts At The "Train" Process Were In The Early 80's In California And Arizona

In Mid 80's, Other States Such As Oregon And New Mexico Began Using The Process

Kansas and New York Began To Use The Process As Well

CIR is Routine Procedure for Many States
Early Research by Gary Hicks and Gordon Mckeen Was Instrumental In the Growth of the Process

ARRA Contractors Worked Diligently to Craft Ever Improving Specifications for Agencies

Improvements In Equipment and Additives Have Contributed to a Better Quality Product
Multi-Unit Trains

► Most Original Work Performed with Long Trains
Classes of CIR

- **Multi-Unit Train**: Pulverize, Screen, Crush, Add Recycling Agent Based on RAP Weight & Mix in Pugmill
- **Two-Unit Train**: Pulverize, Add Recycling Agent Based on RAP Weight & Mix in Pugmill
- **Single Unit Train**: Pulverize, Add Recycling Agent – All in Cutting Chamber of Milling Machine
Modern Multi-Unit Train
Two-Unit Train
Single Unit Train
Mixture is deposited in windrow and placed in paver with pick-up device or deposited directly into paver
CIR – Placement & Compaction

- CIR is harder to compact than HMA (more viscous)
- Heavy Pneumatic roller(s)
- Vibratory Steel Wheeled Roller(s)
Wearing Surface

- Chip Seal
- Slurry Seal
- Micro-Surfacing
- Cold Mix Overlay
- Hot Mix Overlay
Cold Central Plant Recycling (CCPR) is a viable alternative when stockpiles of high quality RAP are available or when it is not possible to in-place recycle the pavement.
CCPR - Process

- Aggregate Feeding/Blending
- Screening/Crushing
- Liquid Metering Systems
- Pugmill Mixing
CCPR - Applications

- Expanded Asphalt (foam) or Emulsified Asphalts are used as Recycling Agent.
- Different Emulsion Formulations are used for Stockpiling versus Immediate Lay.
Bituminous Recycling Agents

- Emulsified Asphalts
  - Engineered Emulsions
  - Solvent Free Emulsions (CSS)
  - High Float Emulsions
  - With or Without Polymers

- Expanded Asphalt (Foam)

- Cement or Lime can be added in small quantities (Recycling Additives) to:
  - Improve Moisture Resistance
  - Decrease Curing Time
  - Increase Initial Strength
**CCPR - Benefits**

- **Environmental.** An excellent use of excess asphalt millings saving valuable natural resources.
- **High Production.** Allows for quick construction time.
- **Economic.** Depending on the cost of the RAP, cost savings can range from 25% to 75% versus conventional hot or cold mix.
- **Mix Properties.** Additional aggregates/additives may be added for enhanced mix performance.
- **Mix Formulations.** With proper additive formulation, the mix may be used in a wide range of applications.
Keys to Long Life CIR

- Project Selection And Site Investigation
- Informed Pavement Design
- Proper Material Selection And Design
- Experienced Contractor And Proper Construction Conditions
Thickness Design

► Wearing Surface Must be Designed to Carry Anticipated Traffic
► AASHTO Procedure: CR “a” coef. of 0.30-0.32 (reported range 0.25 to 0.35)
► Pavement ME (MEPDG)
  ➢ CIR & FDR Not Getting Full Credit
  ➢ NCHRP 9-51 Characterization of Cold In-Place Recycled and Full Depth Reclamation Materials for Mix and Structural Pavement Design
Recent Survey of 13 Agencies using Partial Depth CIR in USA

- 10 of 13 Agencies Reported No Official Traffic Restrictions on CIR Usage
- Majority of CIR has been Performed on Low to Moderate Trafficked Pavements
- 6 of 13 Agencies Reported using CIR on Interstate Pavements
- Performance Studies Indicate Traffic had no Adverse Affect on Performance
No Traffic Restrictions

- Chesner, et al. NYSDOT CIR (TRB 2011)
  - Higher traffic = longer service life
  - Attributed to better quality of base
- NCHRP Synthesis 421 Recycling and Reclamation of Asphalt Pavements Using In-Place Methods
  - Over utilized on lower volume pavements
  - Under utilized on higher volume pavements
CIR Performance

► Nevada
  ■ Use FDR & CIR extensively as part of their Pavement Management System
  ■ Top 5 States Pavement Smoothness

► Kansas
  ■ Performing CIR Over 30 years
  ■ Top 5 States in Pavement Smoothness

► New York – CIR Over 300 projects

► Vermont
  ■ CIR longer service life than Mill & Fill
Sustainability NYSDOT (C-06-21)

* CIR includes 1.5” HMA
CIR Sustainability

► Alkins, Lane & Kazmierowski, *TRR 2084*

► Comparison of CIR to equal thickness of Mill & Fill resulted in:
  - 62% less reduction in aggregate resources
  - 52% reduction CO$_2$ emissions
  - 54% reduction NO$_x$ emissions
  - 61% reduction SO$_2$ emissions
CR Advantages

► Cost Effective
► Conserves Energy
► Conserves Materials
► Improves Mix Characteristics
► Improves serviceability and increases structural capacity
► Reduces Construction Time
► May Be Performed Under Traffic
Thank You

Stillwater, OK
My Home

Heart of Tornado Alley