

Cold In-Place Recycling (CIR)

North Dakota Asphalt Conference April 4, 2012, Bismarck, ND Mark Watson, MnDOT





- What is CIR?
- MN & National CIR Use
- Project Use
 - Challenges (Lessons Learned)
 - Successes
- Summary













In-Place Recycling Terms

- Full Depth Reclamation (FDR)
 - Grind HMA with Base
- Stabilized FDR (SFDR)
 - Grind HMA with 1 to 2 inches of Base & add additive (liquid or dry)
- <u>Cold-in Place Recycle</u> (CIR)
 - Grind HMA ONLY & add liquid additive (can add dry too)













Cold In-Place Recycling

- Partial depth (2 4") of HMA (No Heat).
- Uses mill, crushing and screening units, pavers, mixers & rollers
- Typically leaves a small amount (~1") of HMA for equipment Support















Cutting Width Min. 2500 mm - Max. 3810 mm Cutting Depth 0 - 335 mm 2.44 m to 6.0 width

Pavement In-Place Recycling from Roadtec

1. Mill Pavement

2. Process (Screen & Crush) RAP Material

- 3. Mix Processed RAP with Additives
- 4. Place & Compact CIR













CIR Train in North Dakota



TH 21, Barnes County, ND

- Rural 2-lane, South of Valley City
- CIR 4" @3.2% Emulsion + Granite Chips
- Chip Seal Surface Treatment



② 2012 Performance

2 Sections Perform well after 3 or 5 yrs Some reflective cracking (trans./long.) (Survived floods of 2010)



















- Nat'l. Recycling Center in CA, sponsored by ARRA
- Several 20 Year Performance Reports: NM, WA, PA, NV, NY
- Upcoming NHI Class: "Asphalt Pavement In-Place Recycling"
- Ontario & IA have inspired MN Specs.



- Ramsey & Other Counties in Mn used for 'many years'
- MnDOT Inconsistent Use
 - Late 80's Early 90's Started, then pulled back due to issues
 - One District ~ 100 miles
 - Starting to be Used Again



MNDOT CIR Issues

- Rutting
 - Material Choice? Thickness?
 - Did Mix Designs, then stopped because all came back at 2.0% add oil
- Cure Times (Before Overlay)
 - Material Choice?



- Used MnDOT Specs
- Equipment Requirements
 - Closed Loop System Screened,
 Crushed => Consistent Product
 - Oil Added based on Weight
- Better Mix Design
- Engineered Emulsion => Cure Times, Strength



- 2010: MnDOT Innovation Money:
 5 Stabilized FDR + 2 CIR
 projects in last two years
- One upcoming State project (No Innovation Money)
- County Project: CIR with Engrd. Emulsion & Cement, Chip Seal Surface

TH 27: Project Overview

- Rural 2-lane with 1,400 ADT
- 16+ Miles of CIR ($\frac{1}{2}$ Emulsion + $\frac{1}{2}$ Foam)
- Mill 2", CIR 4" (2" In-Place), 3.5" HMA



IRI: 150's – 220+ Patching Cracking



- Rural 2-lane with 1,400 ADT
- 8+ Miles of CIR (Engr. Emulsion)
- Mill 4", CIR 4" (4*" In-Place), 4" HMA



IRI: 130's – 150+ Patching WP Cracking



- HFMS-MP (Emulsion) @2% (No Design)
- Foamed AC @2% (Mix Design)



(i) Foamed Oil / Emulsion Emulsion ~ 33% H_2O + 67% Oil (2%=1.3%) Foamed AC ~ 100% Oil (2%=2%)





Foamed Bitumen Production in Expansion Chamber















Measure the foaming properties Compare against Design, & Adjust





Foaming Ratio Properties

TH 27: Foamed Mix Design

- Used IA Procedure (Modified Wirtgen)
- Indirect Tensile Strength (Dry/Wet) 66 / 46 (70% Retained)

Fines Needed? (Too Much = Bad)





TH 67: Emulsion Mix Design

Property	Criteria	Purpose
Compaction effort, Superpave Gyratory Compactor	1.25° angle, 600 kPa stress, 30 gyrations Report	Density indicator
Density, ASTM D 2726 or equivalent	Report	Compaction indicator
Retained stability based on long-term stability	70% min.	Resistance to moisture damage
Marshall stability, ASTM D 1559 Part 5, 40° C	1,250 lb min.	Stability indicator
Raveling test, ASTM D7196- 06	2% max.	Resistance to raveling
Indirect tensile test, AASHTO T322, Modified	LTPPBind temperature for climate & depth	Resistance to cracking















- Resistance to Plastic Flow
- Average Retained Strength => Moisture Sensitivity



















Mix Design: Raveling Test

- Evaluate Emulsion/ RAP compatibility
- ASTM D 7196-06 (2% Loss Max.)

1% Loss after 15 minutes



11% Loss after 10 minutes



TH 67: Emulsion Mix Design

- Dry Stability:
- Retained Stability:
- Raveling Test:
- Indirect Tensile :

1,682 lbs. 1,441 lbs. (85%) 0.86% -32°C (Cracking)

RECOMMENDATION (See Conclusion Below)				
3.3% +/- 0.3%	Based on 12 ft. width	gal./ft	gal/SY	
1.5% +/- 0.5%	for 3 in. depth	1.47	1.11	
	for 4 in. depth	1.96	1.47	



- Depth
- Gradation
- Yield (Asphalt Binder)
- Moisture
- Establishing Rolling Patterns (Nuke)

Check Depth & Gradation



- Depth Adjust to Ensure Adequate Support
- 100% passing 1.5"; 90-100% passing 1.0"

Monitor Oil Addition Rate



- Too Much => Rutting issues, \$\$
- Too Little => Failures, Raveling, Durability
 Affected by Temperature & Gradation



Use Nuke Device Check Density (Info. Only) New Test Strip if "Changes"







- Moisture ≤ 1.5 % (weight) ~ 7 10 days before placing HMA.
- If Moisture > 1.5% & < 2.5% & has not changed by more than 0.2% over of five days, the Engineer may allow HMA Placement
- Fog Seal to prevent raveling if open for extended period of time



Recycling will find weak/poor areas

Recycling does not fix Soft Spots



TH 27 Won a Paving Award Another project to be built this year





- Two Items (SY & Ton)
- ~\$1.70 / SY CIR Bit. Mixt.
- \$535 \$683 / TON Oil
 - \$35,700 for Lane*Mile 4" CIR
 - \$38,600 for Lane*Mile 2" HMA

Relaxing equipment Requirements
 Reduced Prices => \$.04/SY



- Conduct Pre-Project Evaluations
 - Existing Pavement Thickness (GPR all Projects)
 - Drainage Evaluations
 - Subgrade/Support Conditions
 - <u>Conduct Mix Designs</u>
 - Evaluate potential products
 - Apply at Proper rates



Measure & Observe During Project

- Gradation
- Bituminous Material
 - Addition Rate, Foaming Properties (if applicable)
- Density Establish a rolling pattern using nukes & continuously observe





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