Engineered Cold In-Place Recycling Best Practices WIN WIN and Save $$$$ By Scott Metcalf
Site Selection: Comparison of Treatments

Pavement Condition

Years

- Fog Seal
- Chip Seal, Slurry Seal and Micro Thin Lift Overlays, Crack Sealing
- Mill and Fill or CIR®
- FDR-EE

Curve shape determined by quality, traffic, climate, etc.
Project Costs Analysis Sonoma County

Cold In Place Recycling Costs (as bid)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quant.</th>
<th>Unit Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIR Mix Design</td>
<td>LS</td>
<td>1</td>
<td>$10,000.00</td>
<td>$10,000</td>
</tr>
<tr>
<td>CIR</td>
<td>SF</td>
<td>342,025</td>
<td>$0.33</td>
<td>$112,868</td>
</tr>
<tr>
<td>Quality Control</td>
<td>LS</td>
<td>1</td>
<td>$13,000.00</td>
<td>$13,000</td>
</tr>
<tr>
<td>Emulsified Recycling Agent</td>
<td>Ton</td>
<td>184</td>
<td>$700.00</td>
<td>$128,800</td>
</tr>
<tr>
<td>Cement Additive</td>
<td>Ton</td>
<td>57</td>
<td>$260.00</td>
<td>$14,820</td>
</tr>
</tbody>
</table>

**Total** $279,488

Cost per Sq. Ft. $0.82
Cost per Sq. Yd. $7.35

Traditional HMA Project Alternative (estimated)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quant.</th>
<th>Unit Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove and Replace</td>
<td>CY</td>
<td>325</td>
<td>$425.00</td>
<td>$138,125</td>
</tr>
<tr>
<td>3/8 Leveling Course (.10 ft.)</td>
<td>Ton</td>
<td>2,565</td>
<td>$108.00</td>
<td>$277,020</td>
</tr>
<tr>
<td>1/2&quot; HMA (.15 ft.)</td>
<td>Ton</td>
<td>3,848</td>
<td>$100.00</td>
<td>$384,800</td>
</tr>
</tbody>
</table>

**Total** $799,945

Cost per Sq. Ft. $2.34
Cost per Sq. Yd. $21.05

Project Cost savings using CIR is approximately $118,000 per lane mile over traditional HMA approach.
Energy Use Per Tonne Of Material Laid Down

Source: The Environmental Road of the Future, Life Cycle Analysis by Chappat, M. and Julian Bilal, Colas Group, 2003, p 34
Recycled materials should get first consideration in materials selection
- Recycling $\Rightarrow$ engineering, economic & environmental benefits
- Review engineering & environmental suitability
- Assess economic benefits
- Remove restrictions prohibiting use of recycled materials without technical basis
When to Utilize Asphalt Recycling

- Anywhere mill and fill is considered
  - Adequate existing pavement thickness
    - 2 to 4 inches in thickness.
    - Thick enough to take to stable base or leave 1” of existing pavement over native soils.
- Will handle all cracking distress provided not sub-grade or base related
- Where surface maintenance is no longer effective
- Where safety is a concern
- When life cycle costs dictate
- When you need to stretch your budget
Do you have roads like this?

- Thermal Cracking
- Poor Ride Ability
- Patched
- Block Cracking
- Dry, Raveled
Road Way Evaluation Project
Selection
Road Way Evaluation for CIR

Note the Staining and Pumping Structural Problems
Construction Issues
Localized weak sub-grade. CIR can not fix sub-grade or base problems. These areas will reflect back right away and need to be fixed.
Candidates

- Distressed Pavement
  - 12-25 years old (typically)
  - Thick enough
    - to leave 1" of existing pavement to support equipment train (normally $\geq 3"$ to 5" thick)
  - Flexible pavement (or bituminous layer over PCC)
  - Structurally sound base
    - CIR will not correct unstable base problems
Ideal Pavement Assessment

- GPR Ground Penetrating Radar
- Soil borings
  - Sample top 6-10 inch
  - Auger to 5 ft. for layer thickness & identification & water table location
- Strength testing options identify weak areas & determine subgrade strength/modulus
  - Falling Weight Deflectometer (FWD)
  - California Bearing Ratio (CBR) or R-Value
  - Dynamic Cone Penetrometer (DCP)
  - Proof rolling (granular surfaces only)

Falling Weight Deflectometer - FWD
CBR device
R-Value Determination (Hveem)
GPR Ground Penetrating Radar

Air-Coupled (Non Contact)
  - Truck Mounted
    - 2 GHz antenna
    - 5 mph to 55 mph Travel Speeds
    - 1 to 6 scans per foot
    - 0” to 24” penetration
    - ¼” asphalt thickness precision
    - Used with Falling Weight Deflectometer
GPR Case Studies

- Unknown Variation in Core
  - City of Santa Ana
- Lateral Trench Detection
Mix Design Process

• Defined sampling procedure, cores taken from various locations. Core samples sent to independent AASHTO approved lab.
Lab RAP Analysis

- Lab
  - Field cores crushed to specific gradation bands
  - A design made for 2 of the gradations

- Field gradation depends upon multitude of factors: milling, weather, etc.
- Gradation compared to lab tested band
- Recycling agent percentage based on applicable gradation
Density Compaction Effort

Superpave Gyratory Compactor or Marshal Compactor
Better Coating / Higher Film Thickness / Lower Voids
Longer Durability

New chemistry coats both fine & coarse materials. However it still needs to be constructible.
Good CIR Candidates

Note: No Pumping or Staining
Cold In-Place Recycling (CIR)

- Train of equipment
  - Mills old pavement
    - Reclaimed asphalt pavement (RAP)
    - Crushes RAP to Gradation
    - Mixes with recycling emulsion
    - Paver Relays recycled mix
    - Compacts
    - Fog Seal
  - Typically place surface treatment in five days
Milling Head
Cracking Pattern is Disrupted
Crusher and Pug Mill Unit

Screen Deck

Crusher Unit

Pug Mill Unit
Emulsion Tanker
Pick Up Machine
Laydown and Rolling
Rolling with 25 Ton Pneumatic Tire Roller

Hwy 111 30,000 ADT
Hwy 111 3 day after CIR
US–191 MP 12.8-21.3

3” Cold In-Place Recycling

3” Cold Central Plant Recycling

Double Chip Seal
Cost Comparison
Conventional Mill & Fill vs. Cold Recycling
(with comparable structural numbers)

- **Total SN of Mill & Fill Section**: 2.83
  - 3.5” New Hot Mix Asphalt: \(3.5 \times 0.42 = SN \text{ of } 1.47\)
  - 6.5” Existing Asphalt: \(6.5 \times 0.21 = SN \text{ of } 1.36\)
  - Existing Base Section

- **Total SN of Proposed Design**: 2.82
  - Double Chip Seal
  - 6” Cold Recycled: \(6 \times 0.33 = SN \text{ of } 1.98\)
  - 3-4” Existing Asphalt: \(4 \times 0.21 = SN \text{ of } 0.84\)
  - Existing Base Section

**Total Cost**

- **Total Cost of Mill & Fill Section**: $2,556,677
- **Total Cost of Cold Recycled Section**: $2,008,314
- **A Difference of**: $548,363 or 21%
US–191 MP 12.8-21.3 Before
Finished Product
Engineered Cold In-Place Recycling

- Summary
  - Defined sampling protocol
  - Engineered design
  - Performance-related specs
  - Early strength & long term durability
  - Engineered for reliability
  - Low user delays
  - 20% to 30% Less than Mill and Fill
  - Cost-effective rehabilitation
CA Resources ARRA.ORG

Scott Metcalf
Ergon Asphalt and Emulsions
1(909)228-2159

Darren Coughlin
Coughlin Company Inc.
1(435)634-1266

James W. Emerson,
Pavement Recycling Systems Inc.
1(951)232-6881

Steve Escobar
Asphalt Pavement & Recycling Technologies (APART)
1(661)393-2748
Questions on CIR-EE ???

Scott Metcalf Ergon Asphalt & Emulsions

Scott.Metcalf@ergon.com
US–191 MP 12.8-21.3

3” Cold In-Place Recycling

3” Cold Central Plant Recycling

Double Chip Seal
US–191 MP 12.8-21.3 Before
US–191 MP 12.8-21.3 Before
Cost Comparison
Conventional Mill & Fill vs. Cold Recycling
(with comparable structural numbers)

Double Chip Seal (No SN)
6" Cold Recycled Section  6 x 0.33 = SN of 1.98
3-4" Existing Asphalt  4 x 0.21= SN of 0.84
Existing Base Section

Total SN of Mill & Fill 2.83
Total SN of Proposed Design 2.82

Total Cost of Cold Recycled Section
$2,008,314

Total Cost of Mill & Fill Section
$2,556,677
A Difference of $548,363 or 21%
Finished Product
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US-191 During Construction
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US-191 During Construction
2 MONTHS AFTER CONSTRUCTION
US-191 2 Years Later