Construction Practices for CIR in North America

Stephen A. Cross, Ph.D., PE

Oklahoma State University

Pavement Recycling & Reclaiming Center

Cal Poly - Pomona

Cold Recycling Process Description

- Pulverizing Existing Pavement
- Sizing of the Reclaimed Asphalt (RAP)
- Addition of new Binder/Additives
- Mixing all Component Materials
- Placement and Compaction of Mixture
- Placement of Wearing Surface

Construction Equipment

Multi-Unit Train Pulverize, Screen, Crush, Add Recycling Agent Based on RAP Weight & Mix in Pugmill

Construction Equipment

Two-Unit Train Pulverize, Add Recycling Agent Based on RAP Weight & Mix in Pugmill

- **Single-Unit Train** - Pulverizes, adds Recycling Agent Based on RAP Weight, Mixes Materials, Places CR Mixture.

Milling Machines for Partial Depth CIR

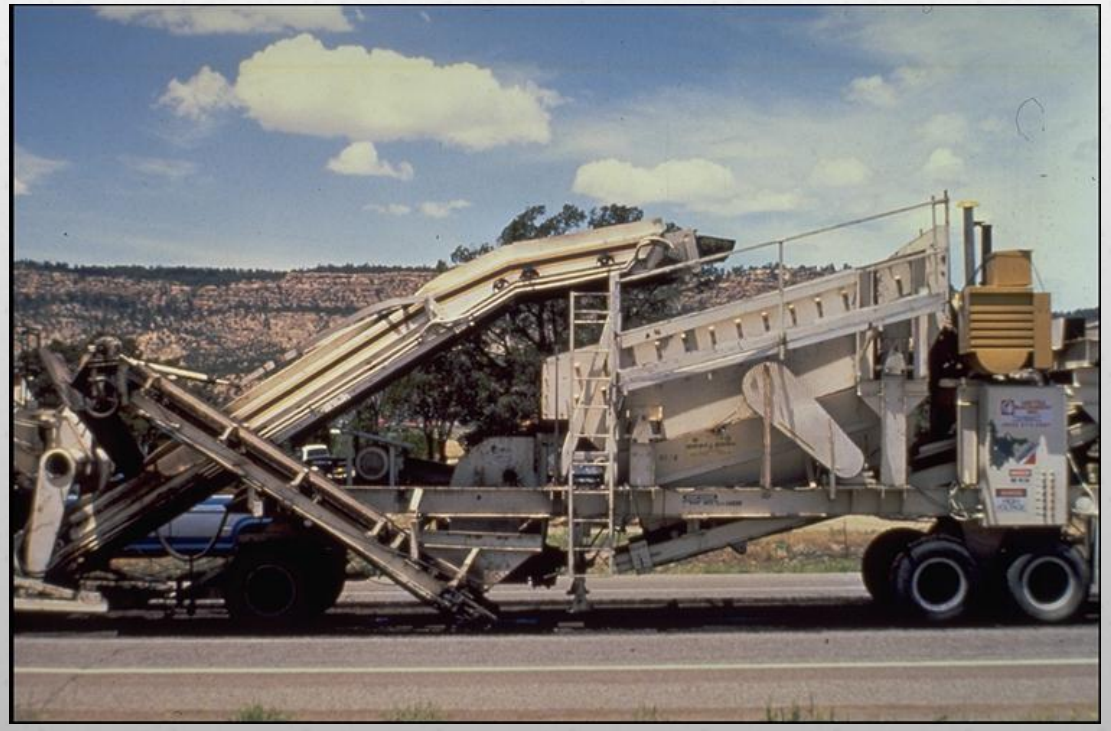
- Mills pavement to required:
  - Depth
  - Cross-slope
- Up-Cutting Mode
  - Higher Production
  - Larger RAP Particles
- Down-Cutting Mode
  - Lower Production
  - Finer Gradation
- Warmer Temperature & Slower Forward Speed = Finer RAP Grading

Crushing & Screening

- **Most Agencies Require Closed Loop System of Crusher & Scalping Screen to Control Maximum RAP Size**
- **Max RAP Size**

  1.0 – 1.5 in.

  (25-40 mm)



Large RAP particles can cause placement & compaction difficulties (segregation, mat tearing, etc.)

Mixing Additives

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- Traveling Pugmills are Required to Mix & Coat RAP with Recycling Agent
- Separate and Combined Units Are Available

Common Additives

- Engineered Emulsions (CSS-1 Special)
  - Controlled Curing/Breaking, Formulated to Resist Raveling, Rutting, Moisture Damage, Crack Resistance
- Solvent Free Emulsions
  - CSS-1 Usually with Lime (CaO)
- Polymer Modified Emulsions
  - HFMS-2P, HFE -150P
- Expanded Asphalt (Foam)

CIR – Additive Application

Slurry Application.

Portland Cement and Hydrated Lime may be applied in slurry form, at cutting head or directly into pugmill.

Dry Application.

Type C Fly Ash, Portland Cement or Hydrated Lime may be spread dry in front of the recycling train. (Environmental Restrictions)

Placement/Laydown

- **Homogenous Mixture is Deposited in Windrow and Placed in Paver With Pick-Up Device**

Placement/Laydown

- **Mix Can Be Deposited Directly Into Paver Hopper or Mix Pavers Can be Used**

Placement/Laydown

- **A Floating Beam or Ski is Often used to Improve Smoothness of CIR Layer**

Compaction

- Compaction of CIR uses same equipment as Hot Mix Asphalt Except Mix is Harder to Compact (More Viscous due Cold Temperature)
- Specify Heavy Pneumatic Roller(s)
  - 25 ton min., min. 65 inch width
- Specify Heavy Double Drum Vibratory Steel Wheel Roller(s)
  - 10 ton min., min. 65 inch width

Compaction

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- Pay Attention to Longitudinal Joint
- Roll Joint First Then Roll From Low to High Side

Compaction - Breakdown

- Roll Until Roller “Walks Out”
- Initial Pass or Passes with Vibratory Roller May be Required

Compaction – Finish Rolling

Use Double Drum Vibratory Steel Wheel Rollers

Adjustments to Mix

- Cold Recycling is a Variable Process
- Existing Mix may not be Uniform Throughout the Project
- Changes in Pavement Temperature Can Cause Changes in RAP Gradation
- Changes in RAP Gradation Cause Changes in Mix Workability

Adjustments to Mix

- **Rigid Adherence to JMF can Result in Less Than Optimal Performance**
- **Many Agencies Allow Changes in Emulsion Content of ± 0.5% Without New Mix Design**
- **Changes Should be Made Judiciously by Experienced Personnel Only**
- **Many Agencies Require Supplier Representative on Site At Startup**

Adjustments to Mix

- **Contractor or Supplier's Representative Inspects Mix to Evaluate Coating and Cohesion**

Adjustments to Mix

- **Mix Should be Adequately Coated**
  - **Poor Coating – Increase Mix Water**
  - **Too Much Mix Water Causes Asphalt to Flush to Surface & Retard Curing**
  - **Too Little Mix Water Causes Segregation, Raveling Under Traffic or Poor Density**

Adjustments to Mix

- If Mix Lacks Cohesion
  - Increase Emulsion Content
  - Too Much Emulsion = Unstable Mix
  - Balling of Fines Can be Indication of Excess Emulsion
  - Too Little Emulsion = Raveling, Minor Raveling is Usually Acceptable
- Change Emulsion in 0.2% Increments, Usually Reduce Mix Water to Keep Total Liquids Constant

Apply Fog Seal

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- Stop Construction minimum of 30 Minutes Before Sundown
- Apply Fog Seal Using Emulsion From Job or CSS-1h or SS-1h
- Dilute 50% with Water and Apply at 0.05 – 0.15 gal/yd^2
- Apply Blotter Sand at 2-3 lbs/yd^2 to Prevent Pick-Up

Wearing Course

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- Chip Seal
- Slurry Seal
- Micro-Surfacing
- Cold Mix Overlay
- Hot Mix Overlay

Wearing Surface

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- All Agencies Reported Designing Thickness of Wearing Surface Based on Traffic
- Typical Reported Thickness:
  - Seals for Low Volume Roads
  - Minimum 1.5 inch (40 mm) HMA
  - 3-4 inch (75-100 mm) for Higher Traffic

Prior to CIR Construction

- Sweep or Blade Roadway to Remove Dirt, Standing Water, Oils, Raised Roadway Markings and other Objectionable Materials.
- Identify Presence of Excessive Crack Filler and/or Geotextiles and Develop Plan to Remove

Prior to CIR Construction

- Adjust Affected Utilities Down and Fill with Cold Mix Asphalt or
- Pre-Mill Around Affected Utilities Prior to Recycling.
- Correct Any Know Areas of Soft or Yielding Subgrade.
- Correct with RAP, HMA, Aggregate
- Correct Drainage Issues

Weather Limitations

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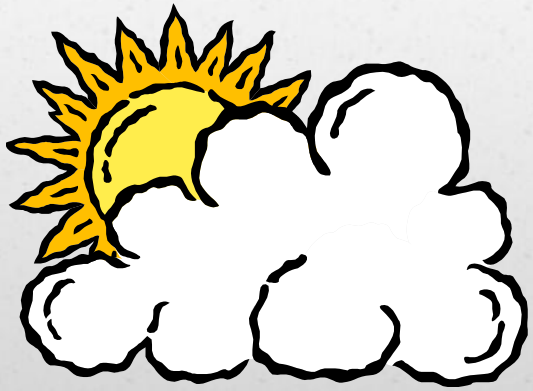

- Air Temperature of > 45 Degrees F. is preferred. Caltrans 50 F & Rising, Pavement 60 F.
- Heavy Rain Must not be Occurring, Imminent or Predicted.

CIR – QA/QC Plan

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1. Just-in-Time Training
2. Calibration of Meters
3. Depth of Milling
4. RAP Gradation
5. Recycling Additive Content
6. Moisture Added to RAP
7. Compacted Density
8. CIR Smoothness
9. Moisture Content Before Overlay

1. Just-in-Time Training

- Familiarize Everyone with Process
- Usually Scheduled 1 Week Before Construction Begins
- Contractor & Owner Agency Personnel Required to Attend
- Can Usually be Exempt by Verified Experience

1. Just-in-Time Training

- Contractor and Owner Agency should Mutually Agree to Instructor and Content
- Course Should Cover:
  - Construction Methods
  - Materials
  - Test Methods Associated with CIR Construction

2. Calibration of Equipment

- Calibrate Belt Scales
- Pumps should be Tied to RAP Weighing System
- Accurate to within 0.5% of Required Rate
- Interlocks Shut Off Pumps When no RAP is Present or Train Stops
- Calibration of Water Meter Not Necessary

3. Check Depth of Milling

- Typical Tolerance ¼-inch (6 mm)
- Positive Means Controlling Cross-Slope
- Frequency of Measurement Varies
- Caltrans 300 feet

4. RAP Gradation

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- Check for Max. RAP Size
- Some Agencies Perform Washed Gradation to Check % Retained No. 4 Sieve to Assist with Adjustments to Additive Contents

5 & 6. Additive Contents

- Emulsion Content From Microprocessor
- Lime or Cement From Meters Accurate to Within 5% Desired Rate
- Water from Microprocessor or Flow Meter

7. Compacted Density

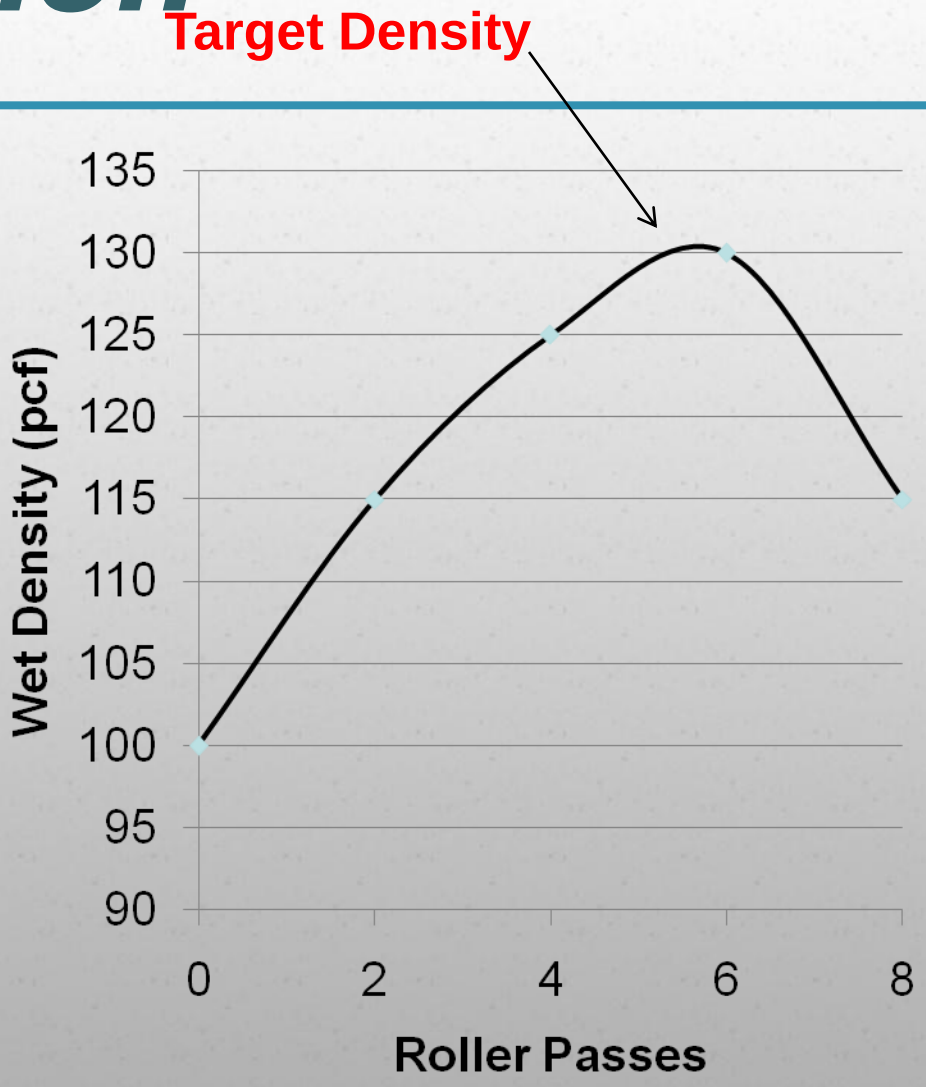
- Use Density Gauge in Backscatter or Direct Transmission
- Record Wet Density
- Frequency of Testing Varies by Agency
  - 1 per 1000 yd^2 or m^2
  - 10 Tests / Day

7. Compacted Density

- **Establish a Control Strip During First Day of Production**
  - **Demonstrate Equipment, Materials & Process Produce Mix Meets Specs**
  - **Determine Optimal Rates for Recycling Additives**
  - **Determine Rolling Pattern Necessary to Obtain Density Requirements (Target Density)**

7. Compaction

- Use 1000 Foot Control Strip
- Monitor Wet Density vs. Roller Passes with Various Combinations to Establish Roller Pattern
- Peak of Curve is Target Density



7. Compacted Density

- %Compaction = $\frac{\text{Wet Density}}{\text{Target Density}}$ X 100

- Compact to 97-103% Compaction
- Majority (95-98%) tests should meet requirement
- Establish new Target Density:
  - Can't Achieved Density Requirement
  - Significant Roller Checking /Cracking

8. Smoothness

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Most Agencies Check Compacted Smoothness of CIR Mat Using Straight Edge (3/8 inch in 12 ft)

- **Correct humps**
  - **Reworking**
  - **Rerolling**
  - **Trimming**
  - **Milling**
  - **Abrasive Grinding**
- **Depressions > 3/8” Tack & Fill with HMA**

9. Moisture Content Before Overlay

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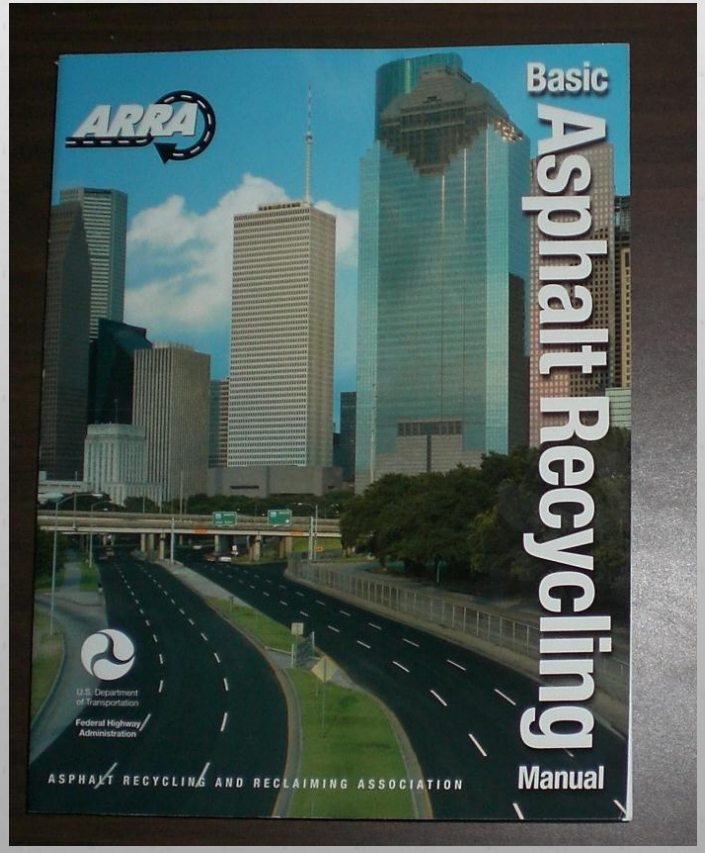
- Most Require Minimum Moisture Content and/or Time Before Placing Wearing Surface
- Specifications
  - Minimum 3 days & < 2.0% Moisture
  - Minimum 10 days Without Rain
  - < 0.3% above Residual Moisture
- Foam cures quickly
- Some Agencies Require Re-Rolling

Coming Soon:

2nd Edition



- www.arra.org
- CIR & FDR Guidelines for:
  - Specifications
  - Mix design methods
  - Project selection
  - Best practices

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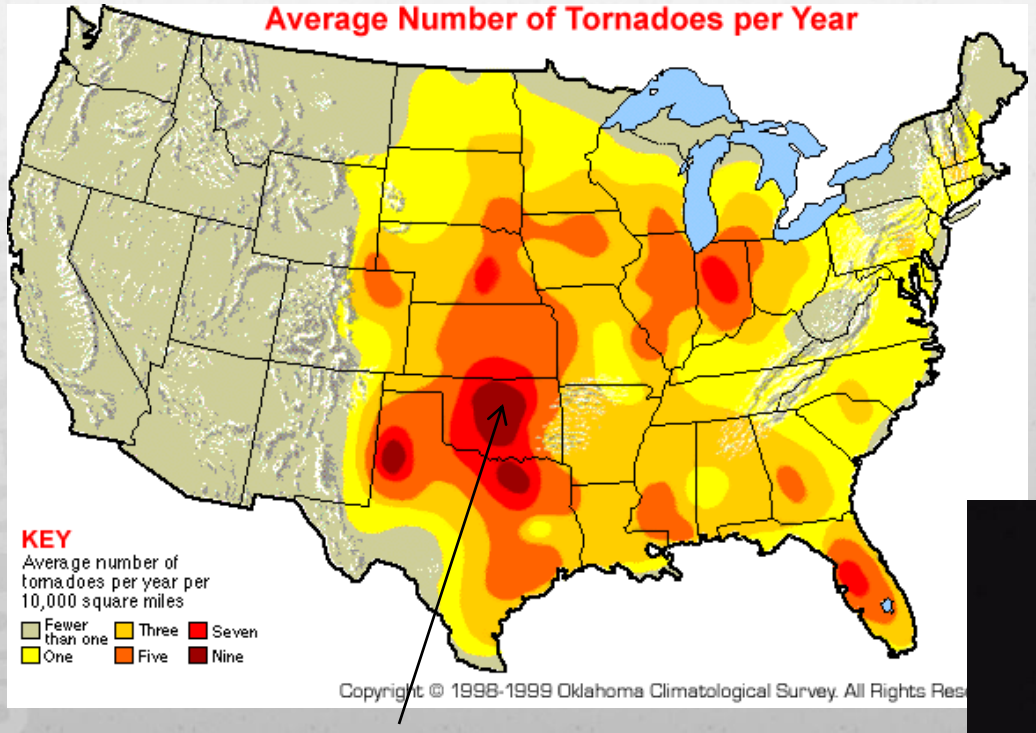
Thank You



steve.cross@okstate.edu
405-744-7200
www.prrcenter.org

Stillwater, OK

Heart of Tornado Alley