Midwestern States In-Place Recycling Conference
CIR/FDR Mix Design Considerations

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WHY DO A MIX DESIGN?

• A mix design ensures that the material will perform in the desired manner
  - Increases the probability of success
• Allows for an accurate, efficient, pavement structural design
  - Known, measurable performance criteria allows the engineer to design the pavement structure
    • Design for strength, flexibility, stability, stiffness, etc.
    • Choose additives, proportions, gradation, to achieve the desired properties
WHY DO A MIX DESIGN?

- Puts engineer in a defensible position for the decisions that were made on a project design.

- How do you know this rehab option is a good or the correct choice?
- Could you have done it cheaper?
- Did you use the correct additive?
- Did you use the right amount of additive?
WHY DO A MIX DESIGN?

• Provides information necessary to make field adjustments
  - CIR
    • Range of emulsion contents
      - Temperature Sensitivity – mix design is done at 73°F
    • Range of gradations
      - Mix design gradation is manufactured in lab
      - Field gradation can depend upon temperature, aggregate size, cutting head
  - FDR
    • Range of additive contents
    • Range of gradations
    • Range of moisture contents
      - Adjustments of additives (cementitious materials) for higher moisture
Cold In-place Recycling (CIR)

Mix Design

Superpave Gyratory Compactor

Lab

Field
Cold In-place Recycling (CIR)

Fundamentals of CIR

Comparison of Conventional and Engineered CIR in Minnesota

- **Conventional**
  - No mix design
  - QC requirements
    - Two gradations per day
    - 100% passing 1-1/2"
    - 90-100% passing 1"
    - Control strip

- **Engineered**
  - Defined sampling protocol
  - Engineered design
    - Emulsion content can range from 1.0% to 4.0%
    - Additional additives for stability (cement, fly ash, add rock)
  - Performance-related specs
Cold In-place Recycling (CIR) Mix Design

RAP/Base Analysis

- Foamed Asphalt, Engineered Emulsion and Fly Ash
  - Field cores crushed to 3 gradation bands
  - A design made for at least 2 gradations
Cold In-place Recycling (CIR)

- Mix design
  - Reclaimed Asphalt Pavement (RAP) crushed to defined gradations
  - Emulsion formulated
  - Superpave Gyratory Compactor (SGC) mixes at field moisture content
- Performance-related tests
Cold In-place Recycling (CIR)

- Test for stability/retained stability
  - Sometimes requires add rock or stiffer binder
- Tensile strength
- Low Temperature Cracking
  - Confirm Binder PG Grade
  - -20°C to -40°C temperature range in MN, ND, IA
  - Typical PG grade is XX-34 or XX-28
Cold In-place Recycling (CIR)
Cold In-place Recycling (CIR)

Graphs showing:
- Density of Specimens vs. Percent Emulsion
- % Vo75 vs. Percent Emulsion
- Marshall Stability vs. Percent Emulsion
Cold In-place Recycling (CIR)
Full Depth Reclamation (FDR)

- Choose Stabilization Technique or Techniques to Evaluate
  - Emulsion
  - Cement/Emulsion
  - Fly Ash/Emulsion
  - Lime
  - Lime/Cement
  - Fly Ash
Full Depth Reclamation (FDR)

Keys to Success

Stabilization Considerations

Prone to Rutting

Surface

Flexible

Granular

Subbase

Prone to Cracking

Stiff

Organic Clay
Full Depth Reclamation (FDR)

Keys to Success

Stabilization Considerations

- Cutbacks or Road Mix
- Proprietary Products
- Engineered Emulsion
- Foam Asphalt or Lime
- Fly Ash or Cement

Prone to Rutting

Flexible

Granular

Prone to Cracking

Stiff

Organic Clay
Full Depth Reclamation (FDR)

- After Stabilization Technique or Techniques are Selected Determine Evaluation Parameters
  - Strength
  - Stability
  - Flexibility
  - Moisture content ranges
Full Depth Reclamation (FDR)

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<th>6% FlyAsh</th>
<th>M.C. 9%</th>
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Full Depth Reclamation (FDR)
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Questions?