CIR/FDR/SFDR Fundamentals

Sponsored by: APANM
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WEGS/Braun Intertec
1. Background Information
2. Definitions/Distress Identification
3. Project Assessment and Rehab Selection
4. Rehab Processes—CIR/FDR/SFDR & more
5. Binder Selection
6. Mix Design & Performance Testing
7. Inspection
Background Information

PL-1 are pavements in "good" condition
PL-3 are pavements in "poor" condition
Data Labels are for the noninterstate system
Rehab “Tool Box” Tools

- Cold in Place Recycling (CIR)
- Cold Central Plant Recycling (CCPR)
- Full Depth Reclamation (FDR)
- Stabilized FDR (SFDR)
- Hot in Place Recycling (HIR)
Additives Used in Recycling

- Foam: 2%
- Fly Ash: 5%
- Other (Kiln dust/CaCl2): 6%
- Lime: 11%
- Emulsion: 16%
- Cement: 20%
- None (dry): 40%
Pavement Life Cycle
Pavement Life Cycle

Curve shape determined by quality, traffic, climate, etc.
Background Process Selection

- Distress Identification
- Project/Pavement Assessment
- Binder Selection
- Mix Design and Performance Testing
- Inspection
- Stacking Hands on Selection
Distress Identification

- Surface Distress – Windshield Survey
- Subsurface Distress – Coring & Boring
- Drainage Related Distress
- Environmental vs. Construction Related
- Performance Testing to address common distress
Distresses can be attributed too:

- **Climate**
  - Transverse cracking
  - Block cracking

- **Structural Deficiencies**
  - Alligator cracking
  - Rutting

- **Materials**
  - Shoving
  - Bleeding
Pavement Condition/Distress Survey

Bituminous Pavement Distresses
Pavement Assessment
Pavement Condition/Distress Survey

Bituminous Pavement Distresses

- Fatigue (Alligator) Cracking
- Bleeding
- Block Cracking
- Corrugation and Shoving
- Depression
- Reflective Cracking
- Longitudinal Cracking
- Patching
- Polished Aggregates
- Potholes
- Raveling
- Rutting
- Slippage Cracking
- Stripping
- Transverse (Thermal) Cracking
- Water Bleeding and Pumping
Pavement Surface Evaluations
Pavement Surface Evaluations
Pavement Surface Evaluations
Pavement Assessment
Pavement Condition/Distress Survey

• How is pavement condition determined?
  – There are numerous resources available to assist in conducting pavement condition surveys:
    • FHWA-SHRP
    • ASTM D5340-93
    • FP² Electronic Guide
    • Corps of Engineers-Micropaver
    • Others?
Pavement Assessment Pavement Condition/Distress Survey

• Procedures generally use a manual with detailed descriptions of:
  – Description of distress
  – Severity level and frequency
  – How to measure
Pavement Subsurface Evaluations

Goal is to determine what’s going on underneath the pavement surface.

Evaluation of inplace materials can be determined destructively (coring) or non-destructively (GPR, FWD):

- Identify underlying conditions (stripping?)
- Identify thickness of inplace materials

- Drainage, Drainage, Drainage ....
Pavement Assessment
Surface and Subsurface Drainage Review

• Visual inspection for presence of:
  – Curb and gutter
  – Ditches
  – Subsurface drainage installed
    • Is it working?

• Soil borings:
  – Base material type
  – Subgrade material type
Pavement Coring

- Confirm inplace materials and review conditions
- Coring performed in non-cracked (sound) pavement areas, as well as on cracks to assess extent of cracking.
Pavement Coring
Pavement Coring
Ground Penetrating Radar

Ground-coupled GPR

Air-coupled GPR
Primary Uses for Roadway GPR

- Determining inplace thicknesses
  - Pre mill-and-overlay or cold in-place recycling (CIR) thickness determination
  - Bituminous and base thickness if considering full-depth reclamation (FDR)
- Layer thicknesses for FWD
- Estimation of construction removal quantities
- QA testing following project completion
GPR Limitations

Weather
- Need clear roads and pavement surfaces
- No heavy rain (equipment damage and surface reflection of signal)

Noise/Interference
- Common sources: FM radio and television towers, two-way radios

Depth
- Typically can see to about 2 to 3 feet (Air Coupled)

Materials
- Similar materials (such as sand-and-gravel base over silty-sand subbase) may be difficult to differentiate
- Materials that are intermixed
GPR for Pavements
Typical GPR Output File

- Pavement Surface
- Bitumino
- Aggregate Base
Presentation of Data
Pavement Strength Evaluation

Evaluation of the structural capacity of an existing pavement can be determined by Falling Weight Deflectometer testing:

- Identify spring load capacity
- Identify potential pavement failures
- In-site R-value for use in pavement design
- Design overlay thickness
Repair Recommendations

Does the roadway meet structural needs?

Review Distresses and Perform FWD Testing
- Provides R-value for design
- Tells us road is structurally sound; 10-tons overall with 200 feet of “weak” area

What are the inplace materials?

Coring and GPR
- Detect severe stripping at bottom of bituminous (eliminates M&OL)
- Approx 8 inches of bituminous over 6 inches of aggregate base

Recommendations
- GE requirements are 20”
- Premill 4”
- 8” FDR & 5” Overlay
- Correct 200 feet of weak area
- No reflective cracking
- Less costly than full recon
- Longer life than M&OL
To assess the following:

- Preventive Treatments (microsurfacing, sealing)
- Overlay/Mill & Overlay
- Hot in Place Recycling (HIR)
- Full depth remove and replace
- Cold in place Recycling (CIR)
- Full Depth Reclamation (FDR)
- Stabilized Full Depth Reclamation (SFDR)
Definitions

- **Mechanical stabilization** - 1st step in reclamation; also used to describe FDR without addition of binder (Pulverization)

- **Chemical stabilization** - FDR with chemical additive (Calcium or Magnesium Chloride, Lime, Fly Ash, Kiln Dust, Portland Cement, etc.)

- **Bituminous stabilization** - FDR with asphalt emulsion, emulsified recycling agent, or foamed / expanded asphalt additive

- **Combination stabilization** - Any 2 or more of above
Definitions

- **Soil** - Sediments or other unconsolidated accumulations of solid particles produced by physical & chemical disintegration of rock - may contain organic matter

- **Granular Base** - Unbound granular material

- **Sand Equivalent Test** - Clay content as % of fine aggregate portion of material (finer than 4.75 mm)
Definitions

- **Stability** - Ability of asphalt mixture to resist deformation from imposed loads; dependent upon both internal friction (aggregate structure) & cohesion (binder)

- **Bound** - Particle structure strengthened with a binding medium such as asphalt or cement

- **Stabilization** - Mechanical, chemical or bituminous treatment designed to increase material stability or otherwise improve engineering properties
Rehab Processes & Selection

- HMA Overlay

- Wearing Surface Layers
- Base
- Subbase
- Subgrade – Fill or Natural Soil
Workshop Outline

1. Background Information
2. Definitions/Distress Identification
3. Project Assessment and Rehab Selection
4. Rehab Processes–CIR/FDR/SFDR &more
5. Binder Selection
6. Mix Design & Performance Testing
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Recycling Options
Bituminous

- Mill, haul and recycle at HMA plant or Cold Central Plant Recycle (CCPR)
- Cold In-place Recycle (CIR)
- Hot In-place Recycle (HIR)
- Full Depth Reclamation
  - Pulverization (FDR)
  - Mechanical Stabilization
  - Bound Stabilization (SFDR)
Recycled materials should get first consideration in materials selection

- Recycling ⇒ engineering, economic & environmental benefits
- Review engineering & environmental suitability
- Assess economic benefits
- Remove restrictions prohibiting use of recycled materials without technical basis
Recycling
Why Recycle?

- Improve serviceability of aged, deteriorated pavements
- Reduce raw material costs
- Level deformations & re-establish crowns
- Retain overhead clearances
Recycling
Why Recycle (Cont)?

- Minimize lane closure time, user delays
- Public acceptance of recycling
- Recycled pavement can be recycled itself
Recycling
When to Recycle?

- Pavement at end of its serviceable life
  - Fatigue (alligator) cracking
- Oxidized
- Raveling of thermal cracks - potholes
- Low clearances under bridges
In-place Recycling
Bituminous Recycling Options

Cold In-Place Recycling

Full Depth Reclamation
Cold In-place Recycling (CIR)
Cold In-place Recycling (CIR)
What is Cold In-place Recycling?

• CIR is the on-site rehabilitation of asphalt pavements without the application of heat during recycling.
• CIR interrupts the existing crack pattern and produces a crack-free layer for the new wearing course.
Cold In-place Recycling (CIR)  
The Train Machine Concept  

Used when the Engineer’s design requires milled material needs to be screened, be of a uniform size and fully mixed in a pugmill.
Cold In-place Recycling (CIR)
Fundamentals of CIR

Comparison of Conventional and Engineered CIR

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

- **Engineered**
  - Defined sampling protocol
  - Engineered design
  - Performance-related specs
  - Early strength & long term durability
Cold In-place Recycling (CIR)
Engineered CIR

Less Raveling – Lab & Field

- Conventional CIR: 25.7% mass loss
- Engineered CIR: 1.6% loss

Raveling in the field

Samples & field photos from CSAH No. 20, Blue Earth County, MN
Cold In-place Recycling (CIR)  
Fundamentals of 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) 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

Superpave Gyratory Compactor

Lab

Field
Cold In-place Recycling (CIR) Environmental Benefits of CIR

• No heat is used during the process thereby reducing the use of fossil fuels and also reducing air pollution.

• Since the existing aggregate and asphalt cement is reused, the need for virgin aggregate and asphalt cement are reduced or eliminated.

• 40% to 50% energy savings can be achieved using this process versus conventional approaches
Cold In-place Recycling (CIR) Applications for CIR

• Good candidates include pavement with:
  – At least 4” of hot mix
  – Adequate base and subgrade
  – Severe pavement distresses

• Poor candidates include pavements with:
  – Inadequate base or subgrade support
  – Inadequate drainage
  – Paving fabrics or inter-layers
Full Depth Reclamation (FDR)
Full Depth Reclamation (FDR) Types of FDR (SFDR)

- **Mechanical stabilization** - FDR without addition of binder (Pulverization)
- **Chemical stabilization** - FDR with chemical additive (Calcium or Magnesium Chloride, Lime, Fly Ash, Kiln Dust, Portland Cement, etc.)
- **Bituminous stabilization** - FDR with asphalt emulsion, emulsified recycling agent, or foamed/expanded asphalt additive
Full Depth Reclamation (FDR)
What is FDR?

• The full thickness of the asphalt pavement and a predetermined portion of the base, subbase and/or subgrade is uniformly pulverized and blended to provide a homogeneous material.

• If new material is not a sufficient base for a new surface course, the reclaimed materials are stabilized by mechanical, chemical or bituminous means.
Full Depth Reclamation (SFDR)
What is SFDR?

Bituminous pavement needing repair

FDR Example
- Overlay
- 6-10 inches stabilized material
- Granular base
- Soil
Full Depth Reclamation (SFDR)
The Construction Process

1. Pulverize, blade & lightly compact before stabilized reclamation
   - Aids in material sizing if additive is added later
   - Corrects road profile, if needed
   - May not be necessary with very powerful reclaimers

2. Adjust moisture, reclaim/stabilize & mix additive (if applicable) with 5-10 inches of in-place with reclaimer or single unit recycler
   - Bituminous & granular material or granular material
3. Compact
   - Padfoot roller
   - Blade to desired profile & remove pad marks
   - Final compaction - pneumatic and/or steel rollers

4. Cover with appropriate wearing surface after curing
Full Depth Reclamation (SFDR) Keys to Success

- Pavement & material assessment
- Engineered mix design
  - Choose correct additive for the application
- Performance-related specifications
- Construction guidelines & QC specs
Full Depth Reclamation (FDR)
Keys to Success

Engineered Mix Design

Superpave Gyratory Compactor
Cohesiometer
Lab Mixer
Engineered Mix Design

- Virgin aggregate or RAP may be needed
  - To increase depth of finished structural layer
  - To improve gradation
    - Cleanliness (P200)
    - Material quality
    - Grading

Add rock
Stabilization Options

- Cutbacks/Roadmix
- Proprietary Products
- Engineered Emulsion
- Lime/chlorides
- Foamed Asphalt
- Flyash/Cement
- Combinations of above
Full Depth Reclamation (SFDR)
Keys to Success

Stabilization Considerations

Prone to Rutting  Surface  Prone to Cracking
Flexible  Stiff
Granular A  Organic Clay B

Subbase
Full Depth Reclamation (SFDR) Keys to Success

Stabilization Considerations

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

Prone to Rutting
Prone to Cracking

Flexible
Granular
Organic Clay

Stiff
Stabilization Considerations

• Engineered Emulsion Technology is formulated for:
  – High asphalt content
  • Good dispersion with higher film thickness
  • Durable
  • Flexible
  – Climate-specific binder
  – Formulated for each project
Stabilization Considerations

- **Fly Ash or Cement Stabilization**
  - Mill to 3”- material
  - Can incorporate some plastic subgrade soils
  - Cement addition rate of 2-4% by weight, fly ash addition rate of 6-10% by weight
  - Short working time due to hydration
- Specific design for each project
- Higher stiffness, lower flexibility
### Full Depth Reclamation (SFDR)
#### Keys to Success

Tests run on 150-mm SGC prepared specimens

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Performance Parameter</th>
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</thead>
<tbody>
<tr>
<td>Short Term Strength by Cohesiometer</td>
<td>Determine if appropriate early curing is occurring</td>
</tr>
<tr>
<td>Retained Strength</td>
<td>Resistance to moisture damage</td>
</tr>
<tr>
<td>Resilient Modulus</td>
<td>Relative indicator of quality</td>
</tr>
<tr>
<td>Indirect Tensile Test (IDT)</td>
<td>Thermal cracking resistance</td>
</tr>
<tr>
<td>Construction &amp; QA/QC Requirements</td>
<td>Reliability</td>
</tr>
</tbody>
</table>

Performance-Related Specification Guidelines

- ASTM D1560
- ASTM D4867
- ASTM D4123
- AASHTO T 322
Full Depth Reclamation (SFDR)  
Keys to Success

Construction and Quality Control

- Equipment
  - Reclaimer
  - Padfoot compactor
  - Motor grader
  - Water truck
  - Finishing Rollers
Full Depth Reclamation (SFDR)
Keys to Success

Construction and Quality Control - Reclaimer

• Typically used in FDR construction
• Typical properties:
  – Center mount cutter
  – 8- or 10-ft wide
  – Accurate emulsion addition
  – Emulsion added to enclosed mixing drum
  – Cement or fly ash added after first pass of reclaimer
  – Road is usually reclaimed a third at a time
Full Depth Reclamation (SFDR) Keys to Success

Construction and Quality Control - Padfoot Compactor

- Best for achieving compaction at bottom of layer
- High amplitude/low frequency
- Back drag blade preferred
- Examples:
  - CAT CP 563C or 563D (rounded pads)
  - Hamm and Hypac
  - SuperPac (34,000 lb)
  - Hyster (28,000 lb)
Full Depth Reclamation (FDR)
Keys to Success

Construction and Quality Control - Motor Grader
Full Depth Reclamation (SFDR)

Keys to Success

Construction and Quality Control - Water Truck

• Many varieties / homemade
• Ability to apply a uniform spray over the width of road
• Adjust initial moisture content, if needed
• Aids in final compaction and appearance
Construction and Quality Control - Finishing Rollers

- Achieve surface compaction & final appearance
- Pneumatic roller
  - 20-ton minimum
  - 90 psi tire pressure
- Vibratory steel roller
  - 10-ton minimum
  - low amplitude/ high frequency
Full Depth Reclamation (SFDR) Keys to Success

Construction and Quality Control

• Field Testing
  – Specific tests & testing frequency determined by agency & road requirements
  • Water content
  • Depth
  • Top size
  • Additive content
  • Compaction
  • Modified Proctor for target density
  • Traffic return
Construction and Quality Control

• Corrective actions
  – Sub-cut & replace weak spots
  – Fix drainage
  – Fix thickness deficiency
    • Add rock
  – Widen
    • Cut out soil
Full Depth Reclamation (SFDR)
Keys to Success

Construction and Quality Control

• Surfacing
  – To support needs of road
  – Structural
    • Traffic
    • Load levels
  – Climate
  – Chip seal at a minimum

Chip Seal
HMA Overlay
Concrete Overlay
Full Depth Reclamation (SFDR)
FDR Expectations

• Site Assessment Critical
  – Can’t fix poor subgrades
  – If pre-construction assessment not done (borings, FWD, etc.), problems should be addressed during construction

• Amount of fines must be manageable
  – If surface or gravel base too thin, may have too many fines unless sufficient additional rock can be added
Full Depth Reclamation (SFDR) FDR Expectations

- Construction start-up expectation
  - Additives shouldn’t be added until moisture content is corrected, most notably
    - On all-gravel roads
    - In heavy rainfall or high water table areas

- Account for variability in road
  - Sufficient sampling & testing
  - Adjust as necessary during construction
Full Depth Reclamation (SFDR)  
FDR Expectations

- May require multiple reclaimer passes
  - For adequate sizing
  - For emulsion dispersion (high fines)
  - For moisture management
- Manage time to compaction when using additives
  - Too soon, soft areas
  - Too late, raveling
Full Depth Reclamation (SFDR)
FDR Expectations

• Traffic control
  – Road may need to be closed during working day
    • Requires working full width of road
  – During construction, local traffic may need access to road if the full road width is being processed
  – During construction, constructing one lane at a time will require a pilot vehicle or an extra lane
Full Depth Reclamation (SFDR)

Applications for SFDR

• Good Candidates include pavements with:
  – Need for upgrading, widening or rehabilitation
  – Bituminous surface on compacted base that:
    • Has sufficient depth to accommodate reclamation process (at least 2" greater than reclamation depth)
      – Exception: Compatible native materials meeting P200 & SE requirements
    • Generally has up to 20% fines (P200)
Full Depth Reclamation (SFDR)
Applications for SFDR

• Good Candidates (Continued):
  – High severity distresses
    • Ruts
    • Base problems
    • Cracks
    • Edge failures
    • Potholes
  – Good drainage or drainage to be corrected
Full Depth Reclamation (SFDR) Applications for SFDR

- Poor Candidates include pavements with:
  - Clay-like native soils
    - Exception: can be stabilized with fly ash or cement
  - Doesn’t meet P200 criteria & can’t or won’t accept added rock
  - Drainage problems
    - Including ditch & regional flooding problems
Full Depth Reclamation (SFDR) Summary

• Builds structure down into pavement
  – Site assessment, sampling & mix design key to success
  – Performance-related design tests & specs improve reliability & performance
    • Early Strength
    • Cured Strength
    • Cracking Resistance
    • Moisture Resistance
    • QA / QC
CIR and SFDR Considerations:

• What is the depth of my existing pavement?
  – CIR is best for pavements at least 5” thick
  – FDR / SFDR is for any depth

• Is the pavement thickness consistent or variable?
  – FDR is better for variable thickness pavements
CIR and SFDR Considerations (Continued):

- What is the condition and strength of the pavement base and subbase?
  - CIR requires base support for the heavy train equipment
  - FDR/SFDR will break up cracking patterns in the base
- What is the required ease of construction?
  - CIR is all done at once
  - SFDR has greater difficulty in getting material placed
CIR and SFDR Differences

For CIR processes a mobile screen deck and pugmill are used to process aggregate and incorporate emulsions, foamed asphalt and/or other liquids or solids.
Cold Central Plant Recycling (CCPR)

- Stockpile RAP (QC very important)
- Crush RAP (Fractionation)
- Mix with Binder (Formulated for project)
- Transport to Project (Handling Time)
- PAVE (Bound recycled mix)
- Compact to specified density
- Apply Surface Treatment or Overlay
- CIR and CCPR
  - Innovations in weigh bridge and liquid metering devices
  - Innovations in the understanding of material additives
  - Emphasis on Mix Quality and Ride Quality
• “Introduction to CCPR”
  – J Wielinski Heritage Research Group 2017

• MnROAD Low Volume Loop
  – Test cells for Engineered Emulsion (EE)
  – Test cells for Foamed Asphalt
Hot inplace Recycle (HIR)
HIR – 3 Processes

- **Heater Scarification**
  - Most common

- **Repaving**
  - Above plus HMA overlay

- **Remixing**
  - Addrock for strength and stability
The Process

Continuous with self-contained train
The HIR Process

- Surface heated to approximately 300°F
The HIR Process

- Softened pavement scarified to depth of 1 - 1½”
The HIR Process

- Engineered emulsion metered at design content
- Softened surface & emulsion milled & mixed
The HIR Process

- Recycled mix placed with paver with vibratory screed
The HIR Process

• Mat compacted
Hot In-Place Recycling Benefits

- Minimizes lane closure time
- Other lanes open during construction
- Quick traffic return
Break

• Why does it work?
Key to improved performance

Max Tensile Strain

50% less on HMA
MnRoad Cells 2,3,4
Performance
Understanding the “Root Cause”

• Great relationships with Team.
• Proper Assessment of entire pavement structure.
• Constant field presence.
• Willingness to take risks
Spreading Dry Binders

- New School
- Old School
• **Modern Vane Spreader**
  – Material application rate controlled by onboard computer that is constantly collecting GPS and ground radar data to apply the proper amount of Portland cement regardless of conditions or the ground speed of the spreader
Cost Savings
Benefits of FDR

Green Savings

40 - 80% COST SAVINGS
80 - 99% FEWER TRUCK LOADS
30 - 80% FASTER CONSTRUCTION TIMES
UP TO 100% REUSE OF PAVEMENT & GRAVEL IN-PLACE
Case Study: 108th Cook County, IL

- Truck Loads: 17
- Total Cost: $370K - $800K
- Work Days: 4 - 8-10
Analysis Procedures for Most Effective Treatment

- A number of procedures for determining cost effectiveness exist and should be used.
- Cost should be part of the decision process but not the only consideration.
- Use of decision trees is a viable method.
  - Cost
  - Life Cycle
  - Pavement Management of Network
  - User Delay
  - Availability of Contractors
  - Availability of Materials

Right Treatment, Right Time, Right Project Done Right!
Example of Selection Process

- Determine Rating Factors
- Assign “Importance Value” to Each Factor
  - Percentage (must total 100)
- Rank each of the Available/Applicable Maintenance Treatments
- Calculate Totals
Example of Selection Process

11-Year Old Pavement, 6000 ADT, Previously Seal Coated, L-Block Cracking, L-Rutting, L-Polished

- Determine Rating Factors
  - Cost
  - How well it “fixes” distresses
  - Traffic Disruption (during maintenance)
  - Traffic Disruption (long term)

- Assign “Importance Value” to Each Factor
  - Percentage (must total 100)

- Rank each of the Available/Applicable Maintenance Treatments

- Calculate Totals

<table>
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<tr>
<th></th>
<th>Chip Seal</th>
<th>Micro</th>
<th>Overlay</th>
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<tbody>
<tr>
<td>30% Cost</td>
<td>5</td>
<td>3</td>
<td>2</td>
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<tr>
<td>50% How well it “fixes” distresses</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>15% Traffic Disruption (during maintenance)</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>5% Traffic Disruption (long term)</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>3.75</strong></td>
<td><strong>4.35</strong></td>
<td><strong>3.15</strong></td>
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- Example of Selection Process
Case Study #2
Case Study #2 Overview
Pavement History

- County State Aid Highway
- Constructed in 1989
  - 5” bituminous pavement
  - 12” aggregate base
  - Clay subgrade
- Constructed with a portion of roadway in the adjacent county
- Abuts a two mile portion of road built in 1941
  - 4” – 5” bituminous pavement (after several overlays)
  - 9” aggregate base
Case Study #2 Overview

Pavement Condition

- Surface condition rating is 3.40
  - Low to moderate transverse, longitudinal and fatigue cracks
- Surface condition rating of the abutting older roadway is 2.80
Case Study #2 Overview
Pavement Strength Evaluation
Surface, Base and Subgrade Analysis

• From the coring report:
  – Surface thickness varies 4.0” to 6.0”
Case Study #2 Overview
Pavement Strength Evaluation
Surface, Base and Subgrade Analysis

• From the coring report:
  – Surface thickness varies 4.0” to 6.0”
  – Average surface thickness is 5”
Case Study #2 Overview
Pavement Strength Evaluation
Surface, Base and Subgrade Analysis

• Spring Season Axle-Load
  – Posting = 9 tons/axle
  – Capacity = 8.3 tons/axle

• Deflection Analysis Results:
  – Effective Subgrade R-value = 7.4

• Structural Analysis Results:
  – Reported GE = 23.2 inches
  – Effective GE = 21.0 inches
  – Mn/DOT Design GE = 30.4 inches
Case Study #2 Overview
Pavement Strength Evaluation
Surface, Base and Subgrade Analysis

<table>
<thead>
<tr>
<th>Test Data</th>
<th>Result</th>
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<tbody>
<tr>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
</tbody>
</table>

![Graph showing pavement strength evaluation results](image-url)
Case Study #2 Overview
Surface and Subsurface Drainage Review

- Ditches are in-place
- Roadway appears to be draining adequately
Case Study #2 Discussion
• Major Consideration:
  – The performance of overlays throughout the history of the abutting older pavement
  • Cracks have propagated through the overlays at a rapid rate
  • Using CIR in similar situations has produced better results on other County projects
Case Study #2 Recommendations

• Engineered Cold In-place Recycling
  – Recycle 4” of the original bituminous pavement
  – Surface with 3” of bituminous pavement
  – Drain tile
Case Study #2 Comparisons

• Different approaches taken by the two counties with this roadway:
  – County #1 chose CIR option in 2004
  • 8 low severity transverse cracks within first 8/10\textsuperscript{th} of a mile (2008)
Case Study #2 Comparisons

– County #2 chose 2” Mill and Overlay option in 2005 with Seal Coat in 2006
  • Over 300 low to moderate transverse cracks and numerous longitudinal and fatigue cracks within first 8/10th of a mile (2008)
The End

• Thank You!