2016 FDR Symposium

Sustainability of FDR and ARRA Resources
Richmond, Virginia
October 25-25, 2016

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Technical Director
Asphalt Recycling & Reclaiming Association
Industry Segments

- Cold Planing
- Hot In-Place Recycling
- Cold Recycling
  - CIR & CCPR
- Full Depth Reclamation
- Soil Stabilization
Pavement Management

- Seal Coats
- Slurry Seals
- Hot In-Place Recycling (HIR)
- Cold Recycling (CIR & CCPR)
- Full Depth Reclamation (FDR)
Full Depth Reclamation

Improves existing materials in-place to provide greater structural support and reduction of imported material.
Types of FDR

- Pulverization
- Mechanical Stabilization
  - Corrective Aggregate
  - RAP
- Bituminous Stabilization
  - Emulsified Asphalt
  - Foamed Asphalt
- Chemical Stabilization
  - Cement, CKD
  - Lime, LKD
  - Calcium Chloride
  - Class C Fly Ash
Full Depth Reclamation
Construction Sequence

Old Asphalt
Base
Sub-base

Existing road

Pulverization to design depth

Pulverized
Sub-base

Removal of excess material (if necessary) and shaping

Pulverized
Sub-base

Addition of stabilizing agents, mixing & compacting

Stabilized
Sub-base

New Surfacing
Stabilized
Sub-base

Final surface course
FDR Engineering Properties

Strength is built into a pavement structure with FDR

- Corrects pavement defects
- Increases structural capacity

3” worn HMA

\[ SN_h = 0.2 \times 3 = 0.60 \]

10” aggregate base

\[ SN_a = 0.11 \times 10 = 1.10 \]

\[ SN_t = 1.70 \]

6” FDR

\[ SN_{FDR} = 0.25 \times 6 = 1.50 \]

7” aggregate base

\[ SN_a = 0.11 \times 7 = 0.77 \]

\[ SN_t = 2.30 \]
FDR Engineering Properties

Strength is built into a pavement structure with FDR

► Corrects pavement defects
► Increases structural capacity

3” worn HMA

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<th>SN&lt;sub&gt;a&lt;/sub&gt;</th>
<th>SN&lt;sub&gt;t&lt;/sub&gt;</th>
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<td>3” worn HMA</td>
<td>0.2 x 3 = 0.60</td>
<td>0.11 x 10 = 1.10</td>
<td>1.70</td>
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<tr>
<td>10” aggregate base</td>
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6” FDR

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<td>7” aggregate base</td>
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SN<sub>H</sub> = 0.42 x 2 = 0.84
SN<sub>FDR</sub> = 0.25 x 6 = 1.50
SN<sub>a</sub> = 0.11 x 7 = 0.77
SN<sub>t</sub> = 3.11
FDR with Cement
Typical Construction Sequence

► Initial Pulverization Pass to break up and blend materials
FDR with Cement

Typical Construction Sequence

- Initial blading/shaping and light compaction
FDR with Cement

Typical Construction Sequence

► Applying cementitious stabilizing agent
FDR with Cement
Typical Construction Sequence

► Second pass – mixing pass
FDR with Cement
Typical Construction Sequence

Compaction and final shaping
FDR with Cement

Typical Construction Sequence

Curing: Either continuous moist curing or application of a curing membrane
FDR must be surfaced

- The most common surface course is an HMA overlay. Chip sealing and/or cape seals can be used for low volume roads and storage lots.
- Typical AASHTO Structural Layer Coefficient 0.15 – 0.25.
- Recent PennDOT study recommended 0.30 – 0.37.
Sustainability - Basics

20 ton load of cement at 5% treats 400 tons material

1-way haul

- 50 - 67 truckloads
- 27 - 31 truckloads
- 19 - 20 truckloads
- 19 - 20 truckloads
FDR vs. New Base

1 mile, 24-foot wide, 6-inch base (PCA)

- Number of trucks needed: 12 vs. 180
- New roadway material—tons: 300 vs. 4,500
- Material lanfilled—cubic yards: 0 vs. 2,700
- Diesel fuel consumed—gallons: 500 vs. 3,000

ARRA Cold Planning
CR vs. HMA Mill & Fill

- Presentations by Charles Schwartz, University of Maryland, 2016 NPPC
- Cradle to Gate Analysis
- Excludes
  - Maintenance
  - Demolition
CR vs. HMA Mill & Fill

- Monitored 16 HMA Plants & 15 Projects
- Monitored approximately 5 CIR & CCPR Projects
- Evaluated GHG Emissions
- FDR would be similar to CIR with a single unit train
CR vs. HMA Mill & Fill

CR provides substantial GHR reduction vs. HMA on a per ton basis
- 43% reduction for CCPR
- 83% reduction for CIR

For fair comparison should be adjusted for unit weight and structural characteristics
- 42% reduction for CCPR
- 80% reduction for CIR

FDR Cement should be in same ballpark
ARRA Resources

► Basic Asphalt Recycling Manual (BARM)
► ARRA Best Practice Guidelines
► TC3 Inspector Training Courses
Sections on:

- Cold Planing
- Hot In-place Recycling
- Cold Recycling
- Full Depth Reclamation

FHWA – HIF-14-001
BARM II

For Each Part - Chapters on:

- Detailed Project Analysis
- Mix Design
- Construction
- Project Specifications and Inspection
Part 5: Full Depth Reclamation
Chapters 14-17

CHAPTER 17: FULL DEPTH RECLAMATION PROJECT SPECIFICATIONS AND INSPECTION

As with all roadway construction processes, two key steps are required to ensure satisfactory construction and performance of a Full Depth Reclamation (FDR) project. First is the development of an adequate and equitable set of specifications and second is inspection of the FDR project during construction to ensure that the intent of the specifications has been achieved.

Specifications describe to the contractor what they are legally obligated to provide an owner agency. Therefore, it is important they are specific enough to protect the owner agency and that they lead to the use of standards and practices that will result in a well-constructed project.

When developing effective specifications, it is important that the right type of specification be used for the right project and that the right elements are included in the specification to ensure successful long-term performance of the treatment. The keys to developing effective construction specifications are to select the appropriate type of specification to ensure that the finished project meets expectations.

There are no established criteria for when to use one type of specification (method, and result or quality assurance) over the other. Owner agencies typically use a combination of the specification types by setting some limitations on materials and equipment and then set minimum levels of performance for the project. Combination specifications leave the contractor with the ability to select materials, equipment and construction methods beyond the minimum to achieve the desired results. However, these limitations increase the risk of the contractor not meeting the project requirements.

Method specifications require the owner agency to describe in complete detail all equipment and procedures that must be used to obtain the desired quality of the project. Method specifications require continuous construction monitoring and require that inspectors work closely with contractors to assure compliance. Writing a good set of method specifications requires that the owner agency preparing the specifications be experienced with all phases of the proposed construction.

With end result specifications, the owner agency tells the contractor what level of performance or end result is expected from the project at a particular time interval and how that performance level or end result will be measured. The contractor selects the construction methods and equipment, job mix formula (JMF), stabilizing agents and additives and construction sequence. At the specified performance interval, the owner agency performs testing to assure that the minimum contract requirements were obtained. Material and field testing of the quality characteristics determined for the project are usually statistically based and therefore, reasonable construction variation of the quality characteristics must be understood and allowed for in the specifications.
# FDR Stabilizing Agent Selection Guide

**Table 15-1: Stabilizing Agent Selection Guide for FDR Mixtures Including RAP**

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**ARRA Best Practice Guidelines**

- **Series 100 Construction Best Practice Guidelines**
  - Suggested Specification Language

- **Series 200 Project Sampling & Mix Design Guidelines**

- **Series 300 QC Guidelines**
  - Recommended Quality Control Checks and Remediation Actions

- **Series 400 Project Selection Guidelines**
  - New FHWA Tech Brief
  - All Provide User Notes for More Information
## Status of ARRA FDR Guidelines

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<tr>
<th>Series</th>
<th>Full Depth Reclamation (FDR)</th>
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Series 100 Construction Guidelines

1. General
2. Treatment Thickness
3. Preconstruction Personnel Training
4. Materials
5. Preconstruction Sampling & Mix Design
6. Equipment
7. Construction
8. Quality Assurance
9. Measurement & Payment
Series 300 Quality Assurance Sampling and Testing Guidelines

1. General
2. Mixing Equipment calibration
3. Recycling Agent Compliance
4. Additive Agent Compliance
5. RAP
6. Water
7. Construction
8. Surface Tolerance & Smoothness
Asphalt Recycling & Reclaiming Association's mission has been to promote the recycling of existing roadway materials through methodologies, to preserve limited natural resources and reduce costs. Numerous challenges are faced with politics, social issues, anti-terrorism policies and procedures, or the continual topic of road maintenance and rehabilitation, and that the methods represent a least expensive, longest lasting alternatives for stretching available dollars.

SAVE THE DATE

PRESIDENT

ESSEX 2015-2016
Other Resources

► PCA
  - Guide to Full Depth Reclamation (FDR) with Cement, EB234, 2008

► Wirtgen
  - Wirtgen Cold Recycling Technology
  - Base Layers with Hydraulic Binders
TC3 Web Based Courses on HIR, CR & FDR

► Hosted by AASHTO
► Free at Checkout
► Module 1: Introduction to Full Depth Reclamation
► ID 2593

The presentation is available as an attachment from the paperclip icon in the bottom right-hand part of the screen.
TC3 Training Resources

- **Hot In-place Recycling (HIR): ID 2590**

- **Inspector Training for Cold In-place Recycling (CIR): ID 2509**

- **Full Depth Reclamation (FDR): ID 2593**
Additional Training Classes

► These Classes!

► ARRA Cold Milling & In-Place Recycling Workshops

► NHI 131050 Asphalt Pavement In-Place Recycling
  ■ 2 brief web based training modules
  ■ 2-day Instructor-led classroom
Magnitude 3.0 Earthquakes

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