Cement-Based Pavement Solutions

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Concrete Airport Pavement Workshop
Atlanta, Georgia

Full Depth Reclamation with Cement
A Useful and Cost Saving Tool

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Portland Cement Association- SE Region
Pavement Distress
Sustainable Solutions
What is sustainable development?

■ "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." World Commission on Environment and Development’s Report Our Common Future (Oxford University Press, 1987).

Paradigm shift –
We have not inherited the world from our forefathers -- we have borrowed it from our children
— ancient proverb
Sustainable Strategies

- Longevity and Lifecycle Cost
- Use of In-Situ Materials
- Recycling and Waste Reduction
- Optimal Material Utilization
- Reduced Energy Use
- Reduced Greenhouse Gas Emissions
- Water Quality and Stormwater Runoff
Examples of Pavement Distress

- Alligator cracking
- Rutting
- Excessive patching
- Base failures
- Potholes
- Soil stains on surface
Figure 5. Typical pavement performance curve indicating the relative timing of various pavement treatments.
Figure 2. Anticipated effect on pavement performance of multiple preventive maintenance treatments.
How do we best Deal with Distressed Pavements that are near the bottom of their Performance Curve

• Many State DOT’s along with City and County Governments now look to Full Depth Reclamation with Cement

• FHWA and State Parks now look to FDR to upgrade their roadways

• Airports are more and more frequently looking at Full Depth Reclamation with Cement to upgrade and improve their facilities
Definition of Reclamation

• Method of flexible pavement reconstruction that utilizes the existing asphalt, base, and subgrade material to produce a new stabilized base course for an asphalt, chip seal, or concrete wearing surface.

The new cement recycled base will be stronger, more uniform, and more moisture resistant than the original base, resulting in a long, low-maintenance life.
Types of Reclamation Methods

• Mechanical Stabilization
• Bituminous Stabilization
  – emulsified asphalt
  – expanded (foamed) asphalt
• Chemical Stabilization
  – portland cement  – kiln dust
  – slag cement  – lime
  – fly ash  – other
What materials can be treated with cement?

- Soils (sand, silt, clay)
- Gravel
- Shale
- Crushed stone
- Slag
- Recycled HMA
- Recycled concrete
Advantages of the FDR Process

- Use in-place materials /Saves Money/Conserve Virgin Material
- Limited hauling of Materials from site
- Maintains existing grade and Restore the Typical Section
- Saves energy by reducing mining and hauling
- Treat all types of pavement distress
- Less Equipment Mobilization
- Reduce construction time (quick return to service)
- Sustainable process
Engineering Benefits

- Retards Reflective Cracking
- Increased Rigidity Spreads Loads
- Eliminates Rutting Below Surface
- Reduces Moisture Susceptibility
- Reduced Fatigue Cracking
- Allows Thinner Pavement Section
When is FDR Appropriate

- The pavement cannot be rehabilitated with simple resurfacing.
- Distress indicates that the problem exists in the base or subgrade.
- Full depth patching is required of more than 15% to 20% of surface area.
- Pavement structure is inadequate for current or future traffic.
# Rehabilitation Strategies

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Rehabilitation Strategy</th>
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<tbody>
<tr>
<td></td>
<td>Reclamation with Cement</td>
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<tr>
<td>New pavement structure</td>
<td>✓</td>
</tr>
<tr>
<td>Fast construction</td>
<td>✓</td>
</tr>
<tr>
<td>Minimal traffic disruption</td>
<td>✓</td>
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<tr>
<td>Minimal material in/out</td>
<td>✓</td>
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<tr>
<td>Conserves resources</td>
<td>✓</td>
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<tr>
<td>Maintains existing elevation</td>
<td>✓</td>
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<tr>
<td>Low cost</td>
<td>✓</td>
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1 mile of 24-foot wide, 2-lane road, with a 6-inch base
FDR DESIGN

• Samples taken at different points along the project by contractor to get representative data.
• Certified lab mixes samples together to attain an average sample for testing. (by Contractor)
• Lab test results submitted to the agency for evaluation and recommendations.

** Design based on .26 Structural coefficient/inch, and we look for a 600 psi when it is practical.
Mix Design

The mix design procedure uses PCA publication:

Soil Cement Laboratory Handbook

Includes the determination of:
- maximum dry density,
- optimum moisture content, and
- compressive strength.

• (If unconfined compressive strength is used to determine cement content, a 7-day strength of 300 to 400 psi is recommended) / Typical designs vary between 2 and 8 percent cement by weight of dry material
FDR Construction Process

Pulverize, Shape, Add Cement, Mix In Place, Compact, and Surface

- **Asphalt Surfacing**
  - Granular Base
  - Subgrade

- **Pulverized**
  - Subgrade

- **Pulverized**
  - Subgrade

- **Stabilized**
  - Subgrade

- **Stabilized**
  - Subgrade

- **New Surfacing**
  - Subgrade

**Existing road**
- Pulverization to desired depth

**Removal of excess material (if necessary) and shaping**

**Addition of cement, mixing, reshaping, and compaction**

**Final surface application**
Road Mix

- Pulverize
- Spread cement
- Add water as necessary for Optimum Moisture and Mix
- Grade and compact
- Cure
- Overlay
Inside a Reclaimer

- Injection of water and/or fluid stabilizing agents
- Operating direction
- Milling drum
- Deep recycled layer
- Distressed pavement
- Granular material
Pulverization

- Pulverize mat to appropriate gradation
- Usually, only one pass is required
Cement Spreading

Cement is spread on top of the pulverized material in a measured amount in either a dry or slurry form.
Blending of Materials and Moisture Addition

Cement is blended into pulverized, reclaimed material and, with the addition of water, is brought to optimum moisture.
Reclamation Train
Compaction and Grading

Material is compacted to 96 to 98 percent minimum standard Proctor density and then graded to appropriate Plan lines, grades, and cross-sections.
Initial Compaction
Most Important Operation
Steel Wheel Final Compaction
Curing

Bituminous Compounds (cutbacks or emulsions)

Water (kept continuously moist)
Testing Requirements

**Gradation/Uniformity**

A common gradation requirement is for 100 percent to pass a 3-inch sieve, a minimum of 95 percent to pass a 2-inch sieve, and a minimum of 55 percent to pass a No. 4 sieve (ASTM C136).

**Density**

A common density requirement is to be between 96 and 98 percent of the established laboratory standard Proctor density (ASTM D558).

**Moisture**

A common moisture requirement is to be within 2 percent of the laboratory established optimum moisture content (ASTM D558).
Density Checks
Life Cycle Tools for Full-Depth Reclamation

- **Life Cycle Cost Analysis (LCCA)** is an economic procedure used to compare competing design alternatives, over the lives of each alternate, considering all significant costs and benefits, expressed in equivalent dollars.

- **Life Cycle Assessment (LCA)** is the examination of a product's environmental aspects and potential impacts throughout its lifetime, including raw material extraction, transportation, manufacturing, use, and disposal.
FDR in South Carolina
How Does SC Measure Progress/Success

• SC has had FDR Contracts performed in 44 of its 46 counties.
• All of the seven SCDOT Districts has active FDR contracts today.
• In the last two + years, SC has contracted over 250 center line miles of FDR work.
• SCDOT has 2 Specialty Crews that accomplished over 40 miles of FDR work each year.
Allison Creek Road
Old Pardue Road
Zion Road
Reclamation of Failed Asphalt Airfield Pavements
Airports Around The Country are Frequently Turning To Full Depth Reclamation with Cement to upgrade their Facilities

Lets Look At Some Of These Projects
2007
Friedman Memorial Airport, Hailey, Idaho

- Single asphalt runway serving the airport

- 7,500 ft long runway. 6,900 ft needed rehab

- Priority No. 1: Minimize runway shutdown time
  - Construction time set at 30 days
Friedman Memorial Airport Runway, Hailey, Idaho

- Planned replacement airport in 10 years

- Three FAA approved methods considered but none could be done within 30 days (fastest construction was estimated at 48 days)

- FAA approved owner’s petition to use FDR

Courtesy of T-O Engineers
Runway Hailey, Idaho

FAA Standard
- HMA 4"
- Crushed - Stone Base 6"
- Subbase 15"

FAA Alternate 1
- HMA 4"
- Crushed - Stone Base 14"

FAA Alternate 2
- HMA 14.5"

FDR Option
- HMA 6"
- FDR 12"
Hailey, Idaho

- FDR with cement was only design alternate of 4 to guarantee reopening in 30 days
Friedman Memorial Airport Runway, Hailey, Idaho

- Constructed within contract time in 2007
- $1 million in construction savings
- Reduced use of virgin materials from quarries
- Eliminated about 4,000 truck trips
- Reduced material disposal
- Reduced fuel use, air emissions, traffic congestion and damage to nearby roads
Friedman Memorial Airport Runway, Hailey, Idaho
Dauphin Island Airport, Alabama

Courtesy of Volkert
Dauphin Island, AL

- **Distress**
  - Raveling
  - Severe cracking
  - Mild base failure

Courtesy of Volkert
Dauphin Island, AL

- High water table

Courtesy of Volkert
Dauphin Island Runway Repair Options

• Remove and Replace
  – Mill existing Asphalt
  – Repair base
  – Place 4” asphalt wearing surface

• Full Depth Reclamation
  – FDR = 7.5 Inches
  – Cement = 45 Lbs./ S.Y.
  – Place 3.5” asphalt wearing surface
Dauphin Island, AL

- Benefits of FDR Option
  - Reduced construction time
  - Higher pavement strength
  - 30% cost savings
  - Conservations of virgin materials and energy savings
Dauphin Island, AL

Courtesy of Volkert
Waycross, Georgia

- 2006
- FDR used to reconstruct old soil cement and asphalt runway
- Runway crossed a second runway presenting grade issues
Waycross, Georgia

- Removed 2” asphalt
- Added sand-clay material to modify gradation
- Place 4” asphalt
Full Depth Reclamation On NC and SC Airports

The use of this procedure is growing with Promising Results & Cost Savings
Reclaimed Asphalt Airports

- Bennettsville SC
- Pageland SC
- Marboro County SC
- Laurens County SC
- Anderson County SC
- Duplin County NC
- Lincoln County NC
- Montgomery County NC
- Harnett County NC
- Raleigh Executive NC
- Brunswick County NC
- Boone County NC
Airports are using FDR in NC

• Last year Montgomery County Airport

This spring two Airports chose Full Depth Reclamation with Cement......

• The Harnett County Airport

• The Raleigh Executive Airport
“Considering our limited budget, we have been looking for ways to stretch our resources with life cycle mentality......We were confident in the consultants recommendation since they had specified this process previously at other airports with successful results. We were pleased with the number of prospective contractors at the pre-bid meeting; it showed us the FDR method had evolved where contractors felt comfortable to compete for these types of aviation projects “
Montgomery County Airport ------NC
Montgomery County Airport ---NC
Montgomery County Airport ---NC
Harnett County  North Carolina
Harnett County North Carolina
Harnett County  North Carolina
Harnett County  North Carolina
Harnett County North Carolina
Harnett County, North Carolina
Harnett County North Carolina
Harnett County  North Carolina
Harnett County  North Carolina
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Raleigh Executive Airport
Pageland, South Carolina

- 2003
- Runway raised to minimize water on the runway
Pageland, South Carolina
Laurens County (SC) used this technique as an alternate type bid on its county airport in 2012.
Laurens County Airport  South Carolina
Laurens County Airport
South Carolina
Anderson County  South Carolina
This year two airports chose Full depth Reclamation with Cement.

Shelbyville is one of those and is hosting an open house today.
Shelbyville Airport
Tennessee
Shelbyville Airport  Tennessee
Shelbyville Airport
Tennessee
Airports in Virginia

Lake Anna Airport
Manassas Airport
Stafford County Airport
Dulles International Airport
Richmond Airport
Williamsburg/New Port News Airport
Military Air Fields

Andrews Air Force Base

Dover Air Force Base
Full depth Reclamation

Today this technique is being used with more and more frequency to satisfy Lifecycle, save money and to speed up the construction process
Virginia Governor Endorses Recycling

- Virginia win national recognition for the I-81 project that utilized FDR.
- Virginia use the FDR process on three major routes in 2012. Rt 3, Rt 10 and Rt 620
- The repaving of one of our most beautiful highways, ‘The Blue Ridge Parkway’, just completed work on the first 16 miles using Full Depth Reclamation with Cement.
- Next section on BR Parkway has just been awarded as we move south.
Full Depth Reclamation Projects in The Carolinas

SCDOT / NCDOT

South Carolina  Experience/Comfort

North Carolina  Interested/Cautious
• 14 years ago SC map would have been blank
• As SC became more comfortable with the process FDR grew rapidly.
• The interest to use FDR in other states is there
• The problems in other states are similar if not identical to those in South Carolina
• FDR is a tool that we all need as we seek to best spend our limited funds and save maintenance dollars..
North Carolina-South Carolina-Virginia
All Three States are Similar

Full Depth Reclamation Contractors are Available

Slurry Pavers          Propst Construction Company
Pozzolonic             Ruston Paving          Site Prep
Boggs Construction     Lineburger Constr Co
Miller Group           Sanders Brothers
Morgan Corporation
If you Decide on Full Depth Reclamation
Make your FDR Projects a Success

- Selection ............ Roads, Airports, Facility
- Location ............ Utilities
- Notification ....... Public
- Inspection ........ Consultant/Agency
- Qualification ........ Contractor
- Coordination ........ Prime/Sub
Full Depth Reclamation with Cement

- Know and understand the Process
- Utilize this technique as a tool
- Monitor the results
- Good Inspection leads to success
Repair versus Fix

• Why put a band aid on the problem...Fix it and take credit for a more permanent solution.
There are many parts to the puzzle when it comes to repairing failing pavements.
Full Depth Reclamation with Cement
...Spending Tax Dollars Wisely!

It Just Makes Good Sense  !!!

Developing and expanding the use of this process as we create a comfort level / trust ......for Cost Effective Sustainable Solutions

Questions ??

Stan Bland
PCA-SE