Tennessee Concrete Pavement and Cement-Based Pavement Solution Conference

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Full Depth Reclamation with Cement
Recycling Our Troubled Pavements In Place

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Full-Depth Reclamation with Cement
Introduction
States Begin Local Paving Programs

The early focus of these programs was to get the local citizens out of the dirt, dust and mud. Departments were judged more on quantity, not quality.
Design at Bare Minimum

- Little ROW
- No Mobilization
- No Traffic Control
- No Erosion Control
- Minimal Grading
- Tight Typical Section
- Minimal Base (4” Mac. / 6” SC/6” TS)
- Bituminous Surfacing
Those were busy years. We built a lot of roads in a short time frame, in every county of the state. We pleased a lot of people. Few questions were asked...

Especially the **big one**!
Who is going to maintain this fast growing, under designed secondary system ????
1960-2000 Hwy. Miles Grow

What was happening with our culture

- Vehicles increased by over 300%
- VMT increased by nearly 400%
- At same time Truck VMT increased at a much faster rate
- Pavement loading increasing at a faster rate than traffic
Trucking Industry

Tractor-semi trailer combination averages 100-200 miles / day or 35,000 – 70,000 miles / year.
Its all about ESALs

- The relationship between axle weight and inflicted pavement damage is not linear but exponential.

- Heavy trucks and buses are responsible for the majority of pavement damage on any highway system.

- An 18,000 Lb single axle load does over 3000 times more damage to a pavement than a 2000 Lb. single axle load.
Challenges Facing Our Roadways

- Continuing growth
- Rising expectations from users
- A heavily used, aging system
- Environmental compatibility
- Changes in the workforce
- Funding limitations

Combined with large increases in traffic volumes and/or allowable loads often leads to serious roadway base failures!
How do you know if you have a base problem and not just a surface deficiency?
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.
So…….How Do We Best Repair These State, County and City Roads

Full Depth Reclamation

With Cement
Definition of Full-Depth Reclamation

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

- THE PAVEMENT CAN NOT 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
Benefits
Advantages of the FDR Process

- Use of in-place materials
- Little or no material hauled off and dumped
- Maintains or improves existing grade
- Conserves virgin material
- Saves cost by using in-place “investment”
- Saves energy by reducing mining and hauls
- Very sustainable process
FDR Advantages

- The process allows for the widening of the existing road while creating a paved shoulder in one operation
- Creates a stronger shoulder and helps to eliminates possible cracking between the paved shoulder and the roadway
- Smaller scale construction operation
- Less equipment mobilization
FDR Advantages

- Ready for immediate local traffic use
- Higher load bearing strength
- Longer pavement Life
- Ability to treat all types of cracking and distress
- No worry about hit and miss full depth patches
- Makes use of our in place investment
- Significant savings
FDR Advantages

- Restores typical section
- Minimizes hauling
- Can be performed under a single lane closure
- Environmentally safe
- Reduces asphalt rates
- Improves the sub grades’ resistance to water penetration
- Fast operation
FDR Advantages

- We are recycling. 100% use of in place materials.
- This meets the GREEN Objective.
Increased Rigidity Spreads Loads

Unstabilized Base

100 psi

15 psi

Full-Depth Reclamation

4 psi
Reduced Moisture Susceptibility

**Unstabilized Granular Base**

Moisture infiltrates base:
- Through high water table
- Through capillary action
- Causes softening, lower strength, and reduced modulus

**Cement-Stabilized Base**

Cement stabilization:
- Reduces permeability
- Helps keep moisture out
- Maintains high level of strength and stiffness even when saturated
Eliminates Rutting Below Surface

Rutting can occur in surface, base and subgrade of unstabilized bases due to repeated wheel loading.

Cement-stabilized bases resist consolidation and movement, thus virtually eliminating rutting in all layers but the asphalt surface.
## Rehabilitation Strategies

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<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>
</tr>
<tr>
<td>Minimal material in/out</td>
<td>✓</td>
</tr>
<tr>
<td>Conserves resources</td>
<td>✓</td>
</tr>
<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
Pavement Thickness Design Procedures

- 1993 AASHTO Pavement Design Guide
  - Structural Numbers
  - Layer Coefficients

- New AASHTO Design Guide
  - Mechanistic-Empirical Design
  - Evaluates effects of pavement materials, traffic loading conditions, environmental factors, design features, and construction practices
Surfaced Roadways in the United States
(2,495,000 total centerline miles)

- Flexible: 82.2%
- Composite: 11.3%
- Rigid: 6.5%
When should we consider Reclamation

- When Full Depth Patching has reached 5% we need to take a serious look at FDR.

- At 12% TO 15% Full Depth Patching, we can perform FDR on the entire road for the same cost and eliminate the guess work of a patching hit and miss scenario.
Resurfacing Contracts

- We want to select the best and most economical method to prepare the road for overlay.
- We need to avoid early and hard to explain premature failure.
- We are selecting the method that will best save future maintenance dollars. Low to minimal maintenance saves time and money.
- We refer to FDR as recycling rather than reconstruction.
SCDOT

Full Depth Reclamation with Cement is a tool that we often utilize.
FDR DESIGN

- Samples taken at different points along the roadway by the contractor to get representative data.

- Certified lab mixes samples together to attain an average sample for testing. (by Contractor)

- Lab test results submitted to OMR for evaluation and recommendations.

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

- Obtain representative samples of roadway material
- Usually about 100 pounds of material is required
- Run sieve analysis (ASTM C136)
- Determine the max. dry density and opt. moisture content at various cement percentages (ASTM D558)
- Typical designs vary between 2 and 8 percent cement by weight of dry material
- Prepare samples
- Cure samples
Strength Determination

- Unconfined Compressive Strength Testing
  - ASTM D1633
  - Used by most governing agencies
  - Simple and quick procedure
  - 7-day strengths ranging from 300 to 400 psi are generally recommended
  - Proven strength (support) under extremely heavy traffic conditions
  - Proven performance (durability) in wet-dry and freeze-thaw environments
FDR Construction Process

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

**Bituminous Surfacing**
- Granular Base
- Subgrade
  - Existing road

- Pulverized
  - Pulverization to desired depth

- Stabilized
  - Removal of excess material (if necessary) and shaping

- New Surfacing
  - Addition of cement, mixing, reshaping, and compaction

- Final surface application
Inside a Reclaimer

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

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

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

Cement is blended into pulverized, reclaimed material and, with the addition of water, is brought to optimum moisture.
Reclaimer and Water Application
Reclaimer and Water Truck Operation
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
Compaction Efforts Begin
Most Important Operation
Final Grading
Steel Wheel Final Compaction
Curing

Bituminous Compounds (cutbacks or emulsions)

Water (kept continuously moist)
Water Operation is Vital
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
Traffic and Surfacing

- Completed FDR base can be opened immediately to low-speed local traffic and to construction equipment.
- Subsequent pavement layers can be placed at any time.
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.
In South Carolina The Situation Is Simple

- SC has the Fourth Largest Highway System
- SC is near the bottom in funding
- 16 cents gas tax (No increase since 1987)
- The under designed system is failing rapidly
- Can’t afford failure and must spend money wisely. Every dollar has to be maximized
- FDP / Overlay and FDR / Overlay can be in the same contract. FDR and FDP (both prepare base for Resurfacing)
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 districts of SC has active FDR contracts today.
- In the last three years, SC has contracted over 250 center line miles of FDR work.
- District 4 FDR Specialty Crew accomplished nearly 35 cl miles of work in its first year.
Allison Creek Road
Old Pardue Road
Zion Road
Full Depth Reclamation on Airports

- FDR is being utilized on airports as well as roadways.
- NC used this technique to repair the badly damaged and aging Montgomery County Airport in 2012.
- Laurens County (SC) used this technique as an alternate type bid on its county airport in 2012.
Montgomery County Airport ----NC
Montgomery County Airport ---NC
Montgomery County Airport ---NC
NCDOT Montgomery County Airport Project
Manager Dion Viventi

“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.”
APWAs are beginning to use FDR on their roadways

- In NC APWAs are beginning to use FDR on more and more projects

- In High Point NC FDR as an alternate saved the city $350,000 on a half mile segment of the Piedmont Parkway.

- Rocky Mount NC often utilizes the FDR process with the upgrade of their roadways.

- Raleigh NC is planning on a $1,000,000 FDR project in 2013.
High Point  North Carolina

Piedmont Parkway Project
Piedmont Parkway  High Point , N C
Piedmont Parkway, High Point, NC
Piedmont Parkway  High Point , N C
Piedmont Parkway  High Point , N C
Piedmont Parkway  High Point, N C
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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’, is begun using Full Depth Reclamation with Cement during 2012.
Blue Ridge Parkway --- Virginia
Blue Ridge Parkway -------VA
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.
Our limited funds have to be spent on real solutions that spend the dollar wisely

Successful resurfacing projects lead to many maintenance free years

FDR is recycling and the public likes this Green Objective

Full Depth Reclamation is a real solution for our roadways and runways
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
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 roads
Full Depth Reclamation with Cement
It Just Makes Good Sense !!!

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

Cost Effective Site Solutions

Questions ??

Stan Bland
PCA-SE