Emulsion Full Depth Reclamation and Granular Base Stabilization - An Engineered Approach

47th Idaho Asphalt Conference
Rocktober 25th, 2007

Full Depth Reclamation (FDR)
What is it?
Rehabilitation technique in which the full thickness of the asphalt pavement and a predetermined portion of the underlying materials are uniformly pulverized and blended to provide as upgraded, homogeneous material.

Emulsion Full Depth Reclamation Process

What is Granular Base Stabilization (GBS)?

- FDR, hold the RAP
FDR and GBS

Granular pavement needing upgrading

Bituminous pavement needing repair

GBS
- Overlay
- Emulsion stabilized material (4-10 inches)

FDR
- Granular base
- Soil

What is FDR?

HMA
- Aggregate Base
- Subgrade

Types of Stabilization

Mechanical stabilization - 1st step in stabilization; also used to describe FDR without addition of a 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

What types of Pavement Distresses can be treated with FDR?

- Cracking
- Poor Ride Quality
- Permanent Deformations
- Poorly Bonded
- Poor Surface
- Shoulder Drop Off
- Inadequate Structure Capacity
Where do you get into trouble with FDR?

- Poor Drainage
- Poor Drainage
- Poor Drainage

Things to consider in designing an FDR Project?

- Historical Information
- Pavement Assessment
- Structural Capacity Assessment
- Material Properties Assessment
- Geometry
- Traffic
- Constructability Assessment
- Environmental Implications
- Economic Assessment

Mix Design

- Emulsion Compatibility
- Performance
- AASHTO and ASTM Testing that directly relate to performance characteristics of the road
- Validated by extensive field testing and experience in many states

Structural Coefficients, AASHTO Example

<table>
<thead>
<tr>
<th>Existing Road Material</th>
<th>Very Dirty</th>
<th>Rounded Ag</th>
<th>Med Quality Ag</th>
<th>High Quality Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Treatment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>&lt; 0.10</td>
<td>0.10 - 0.12</td>
<td>0.12 - 0.14</td>
<td>≥ 0.14</td>
</tr>
<tr>
<td>Hydrated Lime</td>
<td>0.12</td>
<td>0.14</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Cement (CTB) (soil cement)</td>
<td>0.14 - 0.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emulsion (Solvent Bearing)*</td>
<td>0.12</td>
<td>0.12 - 0.16</td>
<td>0.16 - 0.20</td>
<td>0.20 - 0.23</td>
</tr>
<tr>
<td>Engineered GBS</td>
<td>N/A</td>
<td>0.18 - 0.20</td>
<td>0.21 - 0.22</td>
<td></td>
</tr>
<tr>
<td>Engineered FDR</td>
<td>N/A</td>
<td>0.22 - 0.24</td>
<td>0.25 - 0.28</td>
<td></td>
</tr>
<tr>
<td>Foam*</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold-In-Place Recycling (CIR)</td>
<td></td>
<td></td>
<td></td>
<td>0.28 - 0.33+</td>
</tr>
</tbody>
</table>

* Values are from the literature. All values here generalized; each agency has own point of view. Engineered process values validated by FWD.

Coefficients depend upon:
1. Material quality
2. Passing the mix design criteria
3. Passing quality control requirements
## Specifications and Mix Design Guidelines

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Performance Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Term Strength by Cohesiometer ASTM D1560</td>
<td>Determine if appropriate early curing is occurring</td>
</tr>
<tr>
<td>Retained Strength - ITS ASTM D4867</td>
<td>Resistance to moisture damage</td>
</tr>
<tr>
<td>Resilient Modulus ASTM D4123</td>
<td>Relative indicator of quality</td>
</tr>
<tr>
<td>Indirect Tensile Test (IDT) AASHTO T 322</td>
<td>Strain or deflection w/ applied load for structural design</td>
</tr>
<tr>
<td>Construction QA/QC Requirements</td>
<td>Thermal cracking resistance</td>
</tr>
</tbody>
</table>

## Engineered Emulsion Technology

**Formulated for:**
- **Chemical break / Solventless**
  - Earlier strength than conventional emulsions
  - Adhesion characteristics
  - Resistant to moisture damage
  - Dispersion

## The Process

- **Reclaimer**
- **Padfoot Roller**
- **Wheel Roller**
- **Steel Roller**
- **Water Truck**

## Engineered Emulsion Technology, cont.

**Formulated for:**
- **High asphalt content**
  - Good dispersion with higher film thickness
  - Durable
  - Flexible
- **Climate-specific binder**
- **Formulated for each FDR project**
Construction Production Rates

- **Typical production rates**
  - Reclaimer rate (~30-90 ft/min)
  - Daily production approximately 0.5 - 0.75 centerline miles (reclaimer)

Quality Control

- **Specific tests & testing frequency determined by agency & road requirements**
  - Water content
  - Depth
  - Top size
  - Emulsion content
  - Compaction
  - Modified Proctor for target density
  - Traffic return

Pioneer Parkway, Santa Clara City, Utah
Full Depth Recycling with Engineered Emulsion
FDR

August 2007
Project Background

- Pioneer Parkway, Santa Clara City, UT
- FDR Project Limits: 1.2 Miles
- Roadway width is 28 feet
- Reclamation depth is 5.0”
- One lane in each direction
- Contractor: A-T Asphalt

Traffic Volume

- 2006 AADT: 4,310 vehicles per day w/10% Trucks

Existing Pavement Condition

- Primary Pavement Distress:
  - severe cracking - alligator
  - oxidation

Mix Design Information

- Roadway Samples:
  - Asphalt Consistency - 2 to 2-1/2” depth
  - Existing base depth - 7 to 10 inches
- FDR Mix Design:
  - 3.2% water was injected with reclaimer during pre-milling operation to ensure moisture content for proper compaction
  - 4.5% FDR Engineered Emulsion injected with reclaimer
  - Compacted to 97% of maximum field density
FDR Construction Process

Construction process (Cont.)

- Establish Rolling Pattern, 3 rollers
  - Padfoot Roller – Vibratory to ensure bottom up compaction
  - Pneumatic Rubber Tire Roller – Kneading Action
  - Steel Wheel Roller – Finishing of Surface
- Use a Road Grader to maintain the desired smoothness of surface

Convenience to Local Businesses

- The Local Landscape Business and Rock Quarry were able to remain open for business without interruption.
  - Their Quote, “It was nice of the city to select a process that did not interfere with our daily business.”

HMA Paving Operation

- Paving of Roadway when moisture in processed mat is within specified tolerances.
  - Typically paving can take place within 2 to 3 days after the FDR process is completed.
  - (This is climate and weather dependant.)
## Full Depth Reclamation vs. Reconstruction

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3” HMA over 5” FDR</strong></td>
<td></td>
</tr>
<tr>
<td>FDR: 10,950 S.Y. @ $5.35</td>
<td>$58,600</td>
</tr>
<tr>
<td>Emulsion: 300 Tons @ $575</td>
<td>$172,100</td>
</tr>
<tr>
<td>HMA: 4260 Tons @ $85</td>
<td>$361,900</td>
</tr>
<tr>
<td><strong>TOTAL:</strong> $592,600</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4” HMA over 10” UTBC</strong></td>
<td></td>
</tr>
<tr>
<td>Road Ex: 10,220 CY @ $17</td>
<td>$173,750</td>
</tr>
<tr>
<td>Emulsion: 300 Tons @ $575</td>
<td>$172,100</td>
</tr>
<tr>
<td>HMA: 5,680 Tons @ $85</td>
<td>$482,550</td>
</tr>
<tr>
<td><strong>TOTAL:</strong> $883,400</td>
<td></td>
</tr>
</tbody>
</table>

### Savings:
- **$290,800 (33%)**

---

## Summary

- **Fortress FDR/GBS**
  - Builds structure down into pavement
  - Site assessment, sampling & mix design keys to success
  - Performance-related design tests & specs improve reliability & performance
    - Early Strength
    - Cured Strength
    - Cracking Resistance
    - Moisture Resistance
    - Construction Quality
    - QA / QC

---

## A Cost Effective Way of Rehabilitating Roadways

- **Full Depth Reclamation**
- Followed with an HMA Overlay

- Then
- Now!

---

## Thank You

- Longer Lasting Roads