Full Depth Reclamation
FDR Has Been Around A While...
What is Full Depth Reclamation (FDR)?

Full Depth Reclamation is a pavement rehabilitation technique in which the full flexible pavement section and a predetermined portion of the underlying materials are uniformly pulverized and blended together to produce a homogeneous stabilized base course (SBC).
Full Depth Reclamation

1) FDR is a more permanent solution for pavement repair and rehabilitation.

2) “Reconstruction Results Without The Price Tag”

3) FDR uses all of the existing roadway materials, no matter the current condition.

4) FDR may be the “greenest” construction process available.

5) Reduced overlay thickness typically pays for FDR process.
Benefits of FDR

Full Depth Reclamation
- Surface Course: 6-16” FDR
- Subgrade

Mill & Fill
- 1.5” Mill & Fill
- HMA
- Base/Sub-base
- Subgrade

Overlay
- 1.5” Overlay
- HMA
- Base/Sub-base
- Subgrade
Benefits of FDR

With proper design and process selection; cross-slope and/or profile grade adjustments/corrections can be made.
Benefits of FDR

Pavement widening can easily be accomplished.
FDR Candidates

Flexible Pavement Structures

1. Parking Lots
2. Low Volume, Secondary Roads
3. City Streets and Medium Volume Roadways
4. Interstate Highways
5. Private and Regional Airports
Where Can FDR Be Used?

1) Essentially anywhere... FDR is a process that can be applied anywhere that flexible pavements are failing.

2) FDR can also be used to upgrade gravel/dirt and chip-seal roads.

3) The only limitation is a “change in mindset”.
   1) Fix Roads
   2) Instead of Band-Aiding Them
FDR Equipment

1. Reclaimer/Stabilizer

2. Motor Grader

3. Compactors
   1. Vibratory Pad Foot
   2. Pnuematic
   3. Vibratory or Static Smooth Drum

4. Water Truck
The FDR Process

Supplemental Equipment

1. Dump Trucks/Stone Spreader
2. Asphalt Distributor/Tanker
3. Bulk Pneumatic Tankers
4. Calibrated Spreading Units
5. Slurry Equipment
The FDR Process

4 Primary Disciplines

1. Pulverization
2. Mechanical Stabilization
3. Bituminous Stabilization
4. Chemical Stabilization
Pulverization

Most Economical FDR Discipline

In-situ pavement layers and pre-determined amount of underlying materials are pulverized and mixed.

Moisture for achieving the required density is the only additional material added.

*NO STABILIZERS!*
Pulverization

**Typically Used When:**

1. Base, sub-base and/or sub-grade deficiencies are not apparent.

2. Anticipated quality of pulverized base course is sufficient enough to support the anticipated loads after surface course placement.

3. Pulverized base course is acting as a sub-base for an engineered full depth pavement system.
Mechanical Stabilization

1. Involves the incorporation of imported granular materials;
   1. Crushed Virgin Aggregate
   2. Asphalt Pavement Millings (RAP)
   3. Crushed Concrete

2. Can be performed with a single pass or with multiple passes.
Mechanical Stabilization

**Benefits Include:**

1. Improvement in the gradation of the reclaimed material - increased structural stability.

2. The ability to lean in-situ materials containing high concentrations of bitumen, thereby increasing the mixture’s structural stability.

3. Cross-slope and/or profile grade corrections can be made without sacrificing section thickness by importing granular materials.

4. Widening can easily be done without sacrificing section thickness.

5. Can also be used in combination with other stabilizing additives - Bituminous or Chemical.
Mechanical Stabilization

Typically **Best Suited For:**

Low to medium traffic volume pavements exhibiting the typical surface and minor base defects associated with an aged, oxidized and overloaded pavement.
Bituminous Stabilization

1. Involves the incorporation of bituminous stabilizing additives;
   1. Emulsified Asphalt
   2. Foamed/Expanded Asphalt

2. Can be performed with a single pass or with multiple passes;

3. Multiple pass = more consistent injection when in thick or irregular pavement.
Bituminous Stabilization

**Benefits Include:**

1. Cost effective method of improving the strength of a reclaimed material while reducing the effects of moisture.

2. More flexible than other base course materials and chemical stabilizers, offers superior fatigue resistance, and is not prone to cracking.

3. Works well in combination with other additives such as virgin or recycled granular material and/or cement or lime (dry or slurry).
Bituminous Stabilization

Typically Best Suited For:

Medium to high traffic volume pavements exhibiting the typical surface and minor base defects associated with an aged, oxidized and overloaded pavement.
Chemical Stabilization

1. Involves the incorporation of 1 or more of the following chemical stabilizing additives:
   1. Portland Cement (dry or slurry)
   2. Lime - hydrated or quicklime (dry or slurry)
   3. Fly Ash - Type “C” or “F”
   4. Kiln Dust; Cement (CKD), Lime (LKD)
   5. Calcium Chloride
   6. Others/Blends, etc.
Chemical Stabilization

Benefits Include:

1. Allows otherwise unsuitable on-site materials to be turned into strong, structural base or sub-base material for an asphalt pavement.

2. Pavements rehabilitated with chemical stabilization are pavements that would typically require substantial full depth repairs and/or undercuts, or total reconstruction.
Chemical Stabilization

Typically Best Suited For:

Low to high traffic volume pavements showing severe distress caused by heavy wheel loads on base, sub-base and/or sub-grade materials with insufficient strength.
Compaction is **Critical for All FDR Disciplines**

Compaction Sequence:

Initial (breakdown)
- Single Drum Vibratory Pad-foot Compactor

Intermediate
- 25-30 Ton Rubber Tire Roller or Smooth Single or Double Drum Vibratory Compactor

Finish
- Single or Double Drum Roller Operating in Static Mode
Project Evaluation and Additive Selection

MtCARMEL STABILIZATION GROUP INC.

wwwARRA.org
Mix Design & QC/QA

1. Gather as much historical information as possible about the roadway (original design/construction, pavement layers and types, etc.)

2. Critical to know composition and thickness of existing pavement and base/sub-base layers.

3. Test borings and/or core samples accompanied by soil survey information is important when trying to determine proper reclamation technique.

4. Evaluate traffic type and traffic level.
## Chemical Stabilization Additives Based on Soil Types

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Well graded gravel and sand mixtures, little or no fines</th>
<th>Poorly graded gravel and sand mixtures</th>
<th>Silty gravels, gravel-sand-silt mixtures</th>
<th>Well-graded sands and gravelly sands, little or no fines</th>
<th>Poorly graded sands and gravelly sands, little or no fines</th>
<th>Silty sands, sand-clay mixtures</th>
<th>Clayey, sands, sand-clay mixtures</th>
<th>Inorganic silts, very fine sands, rock flour, silty or clayey fine sands</th>
<th>Inorganic clays of low to medium plasticity, clayey clays, sandy clays, silty clays, lean clays</th>
<th>Organic silts and organic silty clays of low plasticity</th>
<th>Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts</th>
<th>Inorganic clays of high plasticity, fat clays</th>
<th>Organic clays of medium to high plasticity</th>
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<tbody>
<tr>
<td><strong>Unified Group Symbol</strong></td>
<td>GW</td>
<td>GP</td>
<td>GM</td>
<td>GC</td>
<td>SW</td>
<td>SP</td>
<td>SM</td>
<td>SC</td>
<td>ML</td>
<td>CL</td>
<td>OL</td>
<td>MH</td>
<td>CH</td>
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<tr>
<td><strong>AASHTO Group Classification</strong></td>
<td>A-1-a</td>
<td>A-1-a</td>
<td>A-1-b</td>
<td>A-1-b</td>
<td>A-1-b or A-3</td>
<td>A-2-4 or A-2-5</td>
<td>A-2-6 or A-2-7</td>
<td>A-4</td>
<td>A-6</td>
<td>A-4</td>
<td>A-5</td>
<td>A-7-6</td>
<td>A-7-5</td>
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</tbody>
</table>
Implementation of Recommended Mix

Prior to start of reclamation:

1. Pre-pulverization depth verification
2. In-situ moisture content determination

During reclamation:

1. Verification of application rates
2. Sample treated materials
3. Cast field samples of treated material for laboratory verification testing
4. Complete density testing of treated material
Care Prior to Surface Treatment

1. Recommend an oil seal/tack/prime coat of 0.15 gal/sy minimum. This should be placed within 24 hours after FDR.

2. Appropriate cure time is required, typically 2 to 7 days depending on treatment used.

3. During cure time keep all heavy loads off of SBC, local traffic may travel on SBC to get to homes/business, etc.
Typical Surface Treatments

1. Chip Seal
2. Double Chip Seal
3. Cold Mix Overlay
4. Hot Mix Overlay
Cass County, MO Route Y

1) This road has been overlayed several times over the last 50 – 75 years.

2) Currently there is 10 – 17” of failing HMA over a weak, wet, fat clay subgrade.

3) Years of heavy loads from quarry hauls, the poor subgrade conditions and the age of the road have pushed, shoved, rutted and cracked it to a state of disrepair.

4) First reaction “This is not safe!”
Route Y Current Conditions
Route Y Current Conditions
MODOT Route Y 2009

1) To maintain existing grade they milled 3” off the surface before FDR treatment.

2) We treated to 14” depth with 4% cement.

3) Very wet, fat clay subgrade.

4) Completed 6 miles in 7 working days.

5) First MODOT FDR project. They’re thrilled, more to come in 2010.
Final Product

Nearly 50% of the millings were used in the new HMA surface.
White County, IN Wind Farm

1) Over 70 miles of local roads that were upgraded before construction started.

2) Treated 12” deep with 8% cement.

3) Only 4” stone wearing course throughout construction (7,000 concrete trucks, heavy equipment, turbines, etc.

4) After completion they paved with HMA or chip-seal.
Kentucky SR 175

1) 1 mile stretch near new quarry.
2) State required quarry to bond road before they started mining.
3) Destroyed the road moving in equipment.
4) 12” FDR with 6% cement.
5) Chip-Seal for 3 months, then paved with 2” HMA.
SUMMARY

Full Depth Reclamation is a process whose time has come… it’s environmentally sound, gives enhanced performance, and saves dollars.

Some of its advantages are:

Conserves Energy - it is completed in-place and on grade so trucking and other material handling issues are eliminated or greatly reduced. Also, no heating fuel is needed since it is a cold process.

Conserves Materials - existing pavement materials (stone and asphalt) are re-used, thus conserving limited resources.

Crown and cross-slope is easily restored.

Reflective Cracking Eliminated - existing cracked pavement is completely pulverized.

Long Term Cost Effective - the cause of pavement failure, weak bases, is addressed.

Environmentally Desirable - disposal of old pavement materials is greatly reduced. There is less air pollution due to no heating and/or material hauling.

Future Maintenance Costs Are Drastically Reduced.
Thank You

More Resources Available at:

www.arrar.org
www.mtcsrg.com