McCARMEL STABILIZATION GROUP INC.

Full Depth Reclamation

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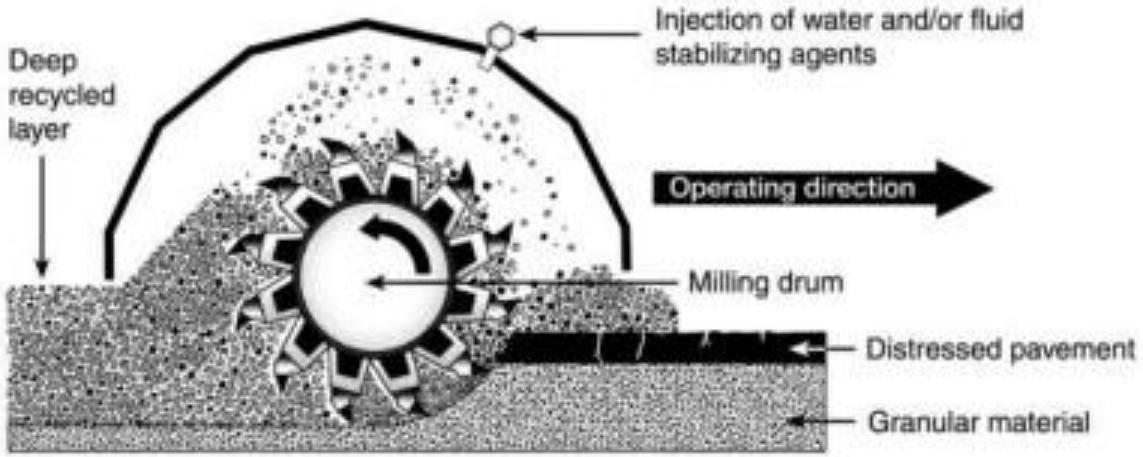
FDR Has Been Around A While…

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).



Benefits of FDR

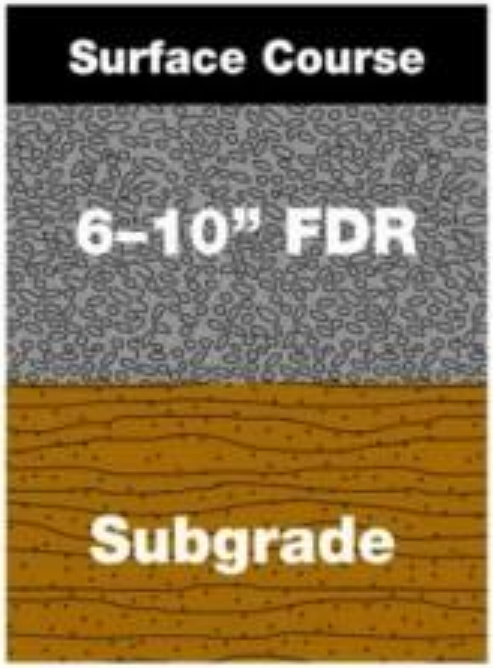
1. Completely erases deep pavement cracking, which eliminates the potential of reflective cracking.

2. FDR can be utilized to depths exceeding 12" (6"to 10" is typical).

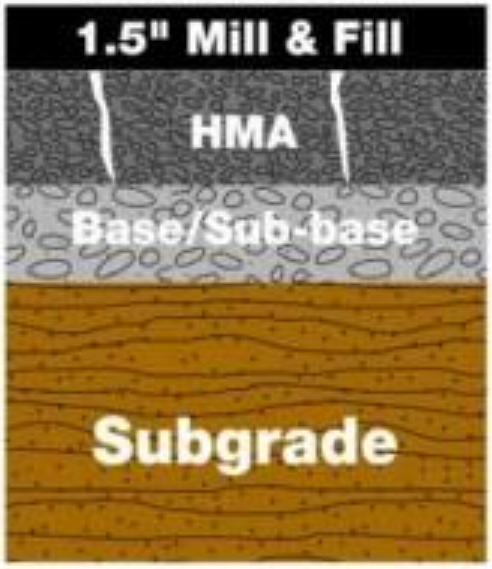
3. Pulverized layers along with stabilizing additives (if any) become a homogeneous, well graded (2"/50mm minus) material with improved structural characteristics.

Benefits of FDR

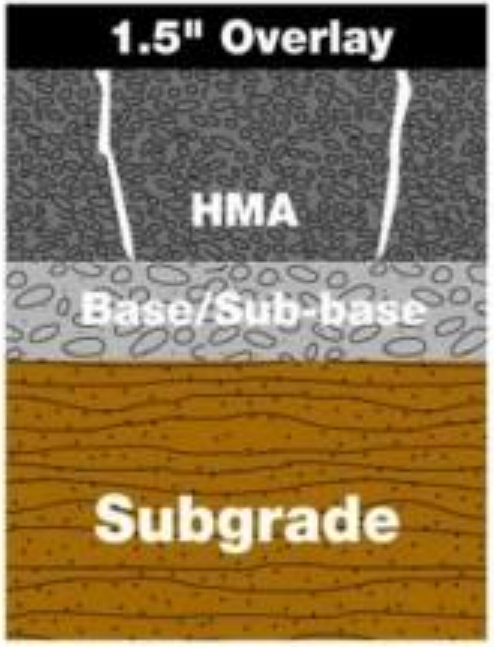
Full Depth Reclamation



Mill & Fill

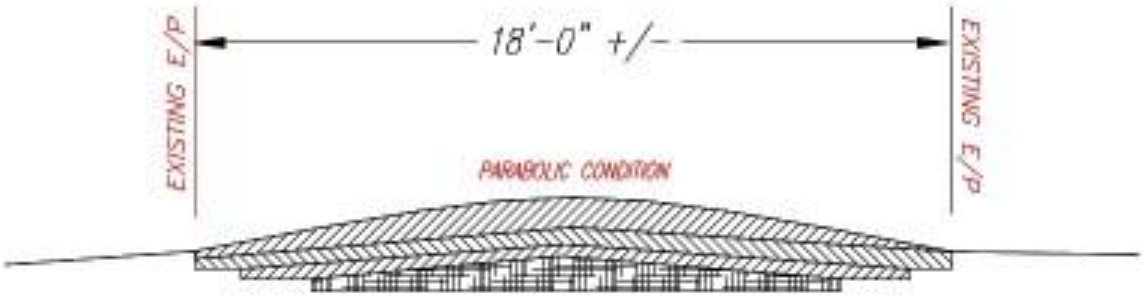


Overlay



Benefits of FDR

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

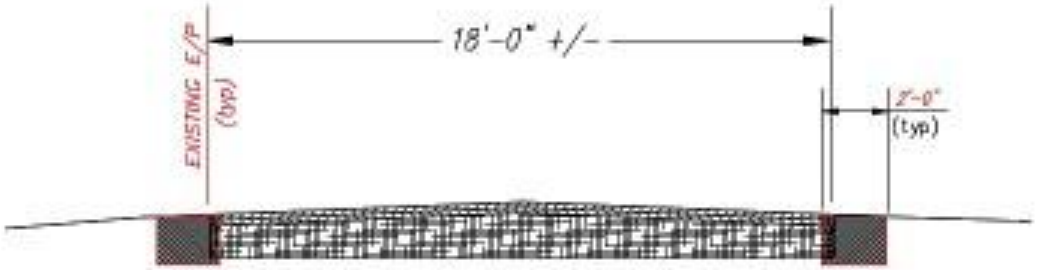


EXISTING SECTION (BEFORE FDR)

PROPOSED SECTION (AFTER FDR)

Benefits of FDR

Pavement widening can easily be accomplished.



EXISTING SECTION (BEFORE FDR)

PROPOSED WIDENING SECTION (AFTER FDR WITH STONE)

PROPOSED WIDENING SECTION (AFTER FDR W/O STONE)

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

FDR Equipment

1. Reclaimer/Stabilizer

2. Motor Grader

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

1. 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

Construction Options

1. Based upon scope of project and the stabilizers being used, there are two construction options:

    1. Single Pass Reclamation
    2. Multiple Pass Reclamation

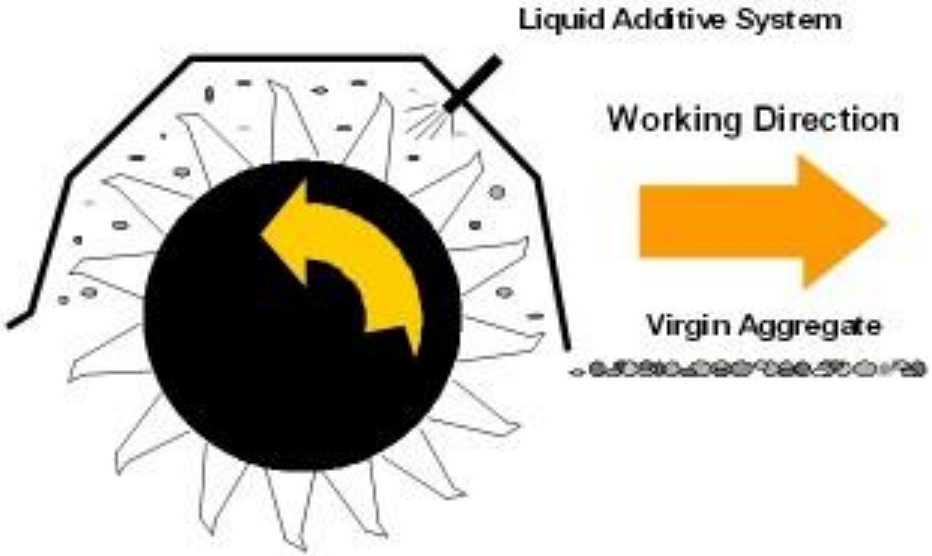
Single Pass Reclamation

Single Pass Typically Used When:

1. Pulverization only - no stabilizing additives

2. No major geometric corrections needed

3. Thin (< 6 in.) asphalt pavement



Single Pass Reclamation

Construction Sequence

1. Pulverize and blend the existing pavement with the underlying layers while simultaneously adding and mixing various stabilizing additives, if any.

2. Fine grade and compact the SBC.

3. Fog seal or prime the SBC, as required.

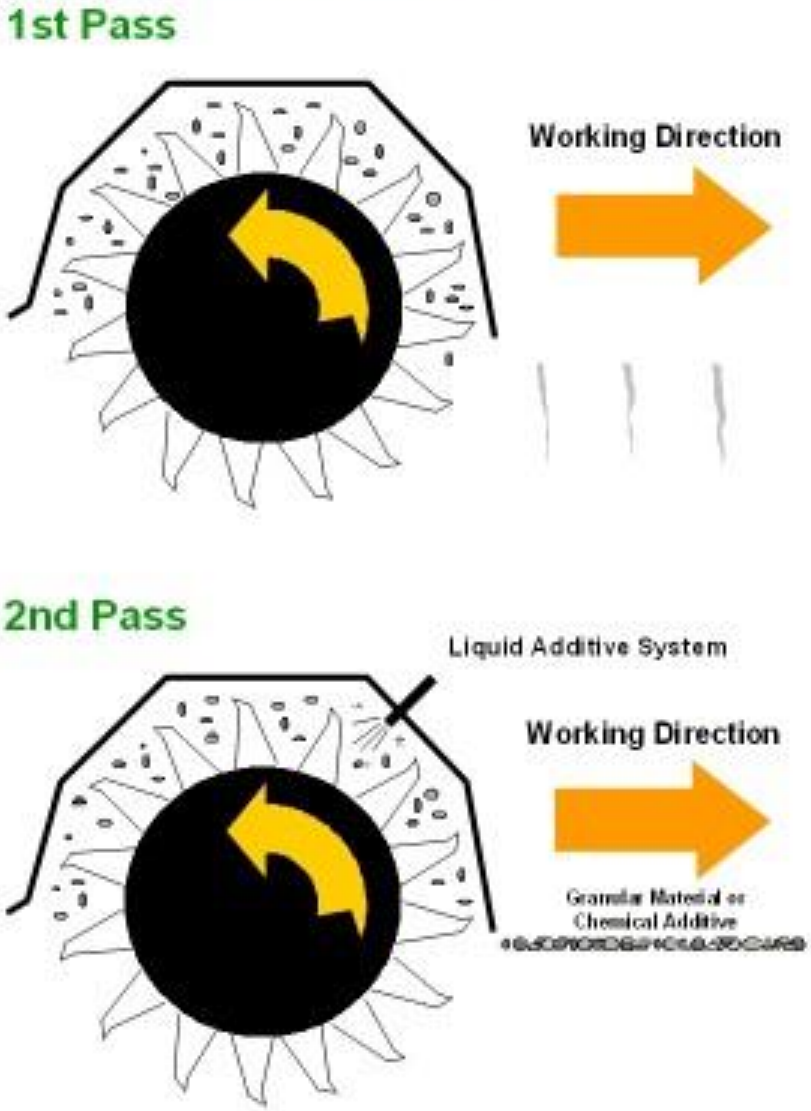
4. Apply the specified surface treatment.

Multiple Pass Reclamation

Multiple Pass Used When:

1.One or more stabilizers added Major grade or profile corrections needed

1. Thick (> 6 in.) asphalt pavement
2. Pavement being widened



Multiple Pass Reclamation

Construction Sequence

First Pass

1. Pulverize and blend the existing pavement with the underlying layers.
2. Pre-shape and compact the pulverized material.

Second Pass

- Apply and mix stabilizing additives.
- Fine grade and compact the stabilized material.
- Fog seal or prime the SBC, as required.
- Apply the specified surface treatment.

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

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Project Evaluation and Additive Selection

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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

Soil Type	Well graded gravels and gravel sand mixtures, little or no fines	Poorly graded gravels and gravel sand mixtures, little or no fines	Silty gravels, gravel-sand-silt mixtures	Clayey gravels, gravel-sand-clay mixtures	Well-graded sands and gravelly sands, little or no fines	Poorly graded sands and gravelly sands, little or no fines	Silty sands, sand-silt mixtures	Clayey, sands, sand-clay mixtures	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Organic silts and organic silty clays of low plasticity	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	Inorganic clays of high plasticity, fat clays	Organic clays of medium to high plasticity	
Unified Group Symbol	GW	GP	GM	GC	SW	SP	SM	SC	ML	CL	OL	MH	CH	OH	PT
AASHTO Group Classification	A-1-a	A-1-a	A-1-b	A-1-b	A-1-b	A-1-b or A-3	A-2-4 or A-2-5	A-2-6 or A-2-7	A-4	A-6	A-4	A-5	A-7-6	A-7-5	A-8
Recommended Additives	Portland Cement/ LFA Blend								Lime Kiln Dust/ Lime Pozzolan				Quicklime/ Hydrated Lime		

TABLE 3: General Guidelines for Selecting Stabilizers for FDR – Laboratory Testing

Characteristics of Reclaimed Pavement Materials	Type and Typical Trial Percents of Stabilizer
Reclaimed asphalt pavement (RAP) having some amount of silty-clay soil from subgrade with a plasticity index (P.I.) greater than 10.	Lime-pozzolan (6-8% by weight) Hydrated Lime (2-6% by weight)[1]
Materials consisting of 100% RAP or blends of RAP and underlying granular base or soil. The soil fraction can have plasticity or be similar to soils acceptable for lime treatment.	Fly Ash (6-14% by weight)[1]
Materials consisting of 100% RAP or blends of RAP and underlying granular base or non-plastic or low plasticity soils. There should be sufficient fines to produce an acceptable aggregate matrix for the cement treated base (CTB) produced (not less than 45% passing the 4.75 mm or No. 4 sieve preferred).	Cement (3-8% by weight)
Materials consisting of 100% of RAP and underlying granular base or non-plastic or low plasticity soils. The maximum percent passing the 75µm (No. 200) sieve should be less than 25%, the plasticity index less than 6 or the sand equivalent 30 or greater, or the product of multiplying the P.I. and the percent passing the 75µm (No. 200) sieve being less than 72.	Emulsified Asphalt (1.5-4.5% by weight)[2] Determine the optimum emulsion content based on the averages for maximum stability and maximum density for the mixture specimen.
Materials consisting of a blend of RAP and non-plastic base soils with 8-12% minus 75 micron material. Small amounts of clay 3-5% are also beneficial.	Calcium Chloride (35% minimum solution at a rate of 0.45 to 0.68 l/m^2 for every 25 mm of depth, (0.10 to 0.15 gallons/square yard for every inch of depth)).

TABLE 4: Testing Methods for Evaluation of Stabilized Materials FDR – Laboratory Testing

Type of Stabilizer	Testing Procedures Applicable
Hydrated Lime (2 to 6% by weight) Lime-Pozzolan (6 to 8% by weight)	Liquid Limit, Plastic Limit and Plasticity Index of Soils, AASHTO T90 or ASTM D4318 Moisture Density Relations of Soils and Soil-Aggregate Mixtures, AASHTO T99 or ASTM D698 or D1557 Unconfined Compressive Strength of Compacted Lime Mixtures, ASTM D5102, Procedure B
Fly Ash (6 to 14% by weight) Cement (3 to 8% by weight)	Moisture-Density Relations of Soil-Cement Mixtures. AASHTO T134 or ASTM D558, Method B Compressive Strength of Molded Soil-Cement Mixtures, ASTM D1633 Wetting and Drying Compacted Soil-Cement Mixtures, ASTM D559, Test Method B
Asphalt Emulsion (1.5 to 4.5% by weight typical)	Refer to Guidelines and design process for Full Depth Reclamation listed in Chapter 2, Section 7 of Bulletin 27 "Bituminous Concrete Mixtures, Design Procedures and Specifications for Special Bituminous Mixtures".
Calcium Chloride (Use a minimum of 35% solution at a rate of 0.45 to 0.68 l/m^2 for every 25 mm of depth, (0.10 to 0.15 gallons/square yard for every inch of depth)).	Liquid Limit, Plastic Limit and Plasticity Index of Soils, AASHTO T90 or ASTM D4318 Moisture Density Relations of Soils and Soil-Aggregate Mixtures, AASHTO T99 or ASTM D698 or D1557

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

Weather Limitations

Based on Type of Stabilizing Additive Used;

Pulverization or Mechanical
(less restrictive)

Bituminous or Chemical
(much tighter)

Care Prior to Surface Treatment

1. Don't Trap Moisture in the SBC.

2. Appropriate cure time is required, typically 3 to 7 days depending on treatment used.

3. Predetermined SBC Moisture Content may be Specified Prior to Applying Surface Course.

Typical Surface Treatments

1. Double Chip Seal
2. Cold Mix Overlay
3. Hot Mix Overlay

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 Reduced.

Thank You

More Resources Available at:

www.arra.org