Southeastern States In-Place Recycling Conference

Full-Depth Reclamation Overview

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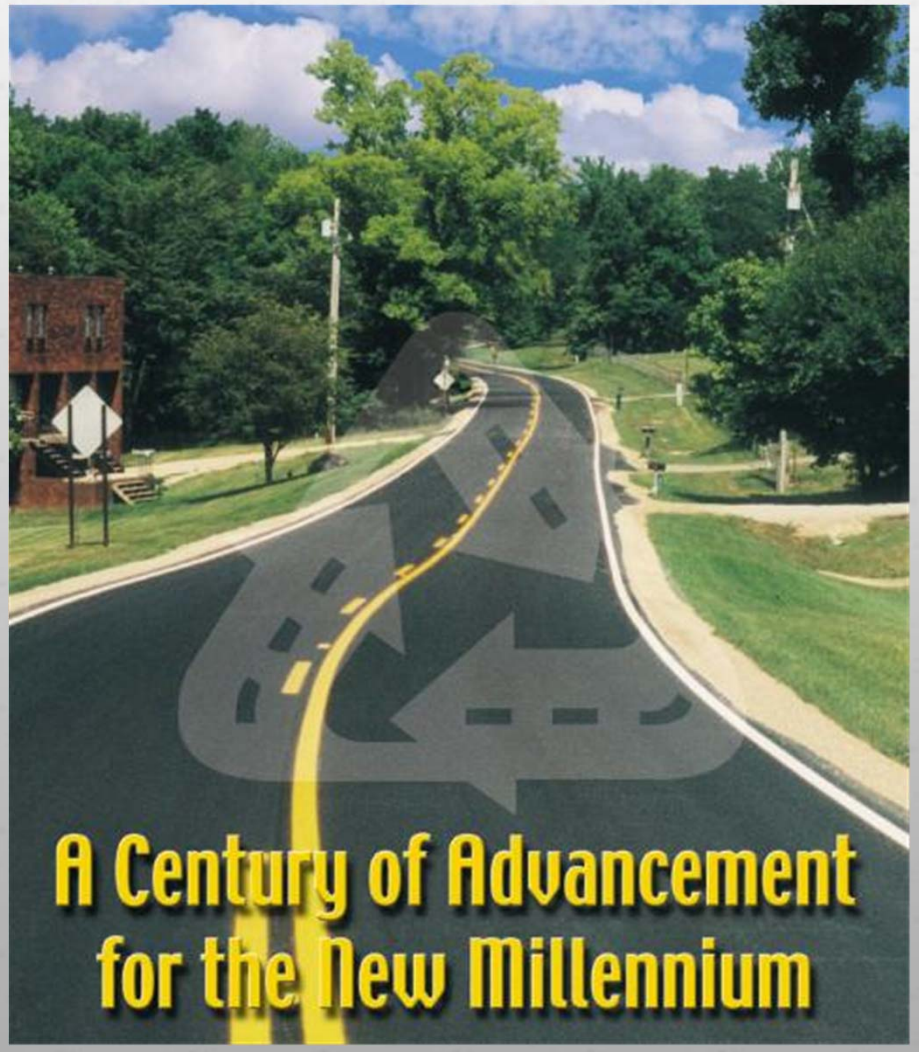
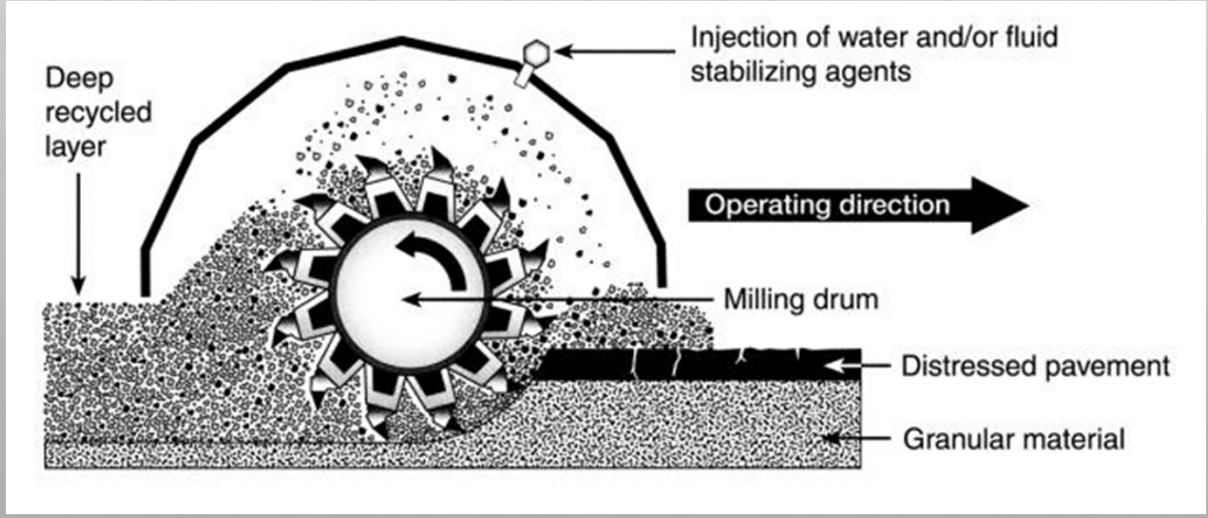
04/17/2010

Full-Depth Reclamation



What is FDR?

- **A Full Depth Reclamation is a pavement rehabilitation technique in which the full flexible pavement section and a pre-determined portion of the underlying materials are uniformly crushed, pulverized or blended, resulting in a stabilized base course (SBC); further stabilization may be obtained through the use of available additives.**

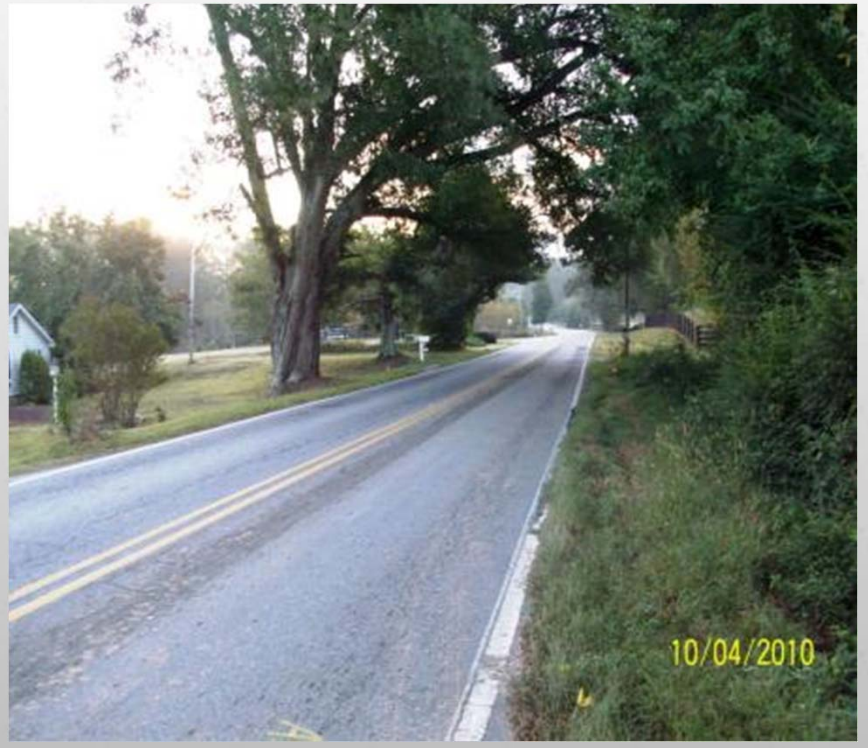


Comparison

- **FDR is distinguished from other rehabilitation techniques such as Cold Planning, Cold In-Place Recycling and Hot In-Place Recycling by the fact that the rotor or cutting head always penetrates completely through the existing asphalt layer and into the underlying base, sub-base or sub-grade layers.**

FDR Candidates

- **Flexible Pavement Structures**
  - **Parking Lots**
  - **Low Volume, Secondary Roads**
  - **City Streets**
  - **Medium Volume Roadways**
  - **Interstate Highways**
  - **Private and Regional Airports**



Existing Conditions

FDR Main Steps

- Analyze existing materials
- Pulverize Existing Pavement
- Introduce Additive and Mix
- Shape the Mixed Material
- Compact
- Apply a Wearing Course

FDR Scope

- Mixing
- Grading
- Compaction

FDR Process

- **Core Equipment**
  - **Road Reclaimer**
  - **Motor Grader**
  - **Compactors**
  - **Vibratory Pad-foot**
  - **Pneumatic**
  - **Vibratory/Static Smooth Drum**
  - **Water Truck**

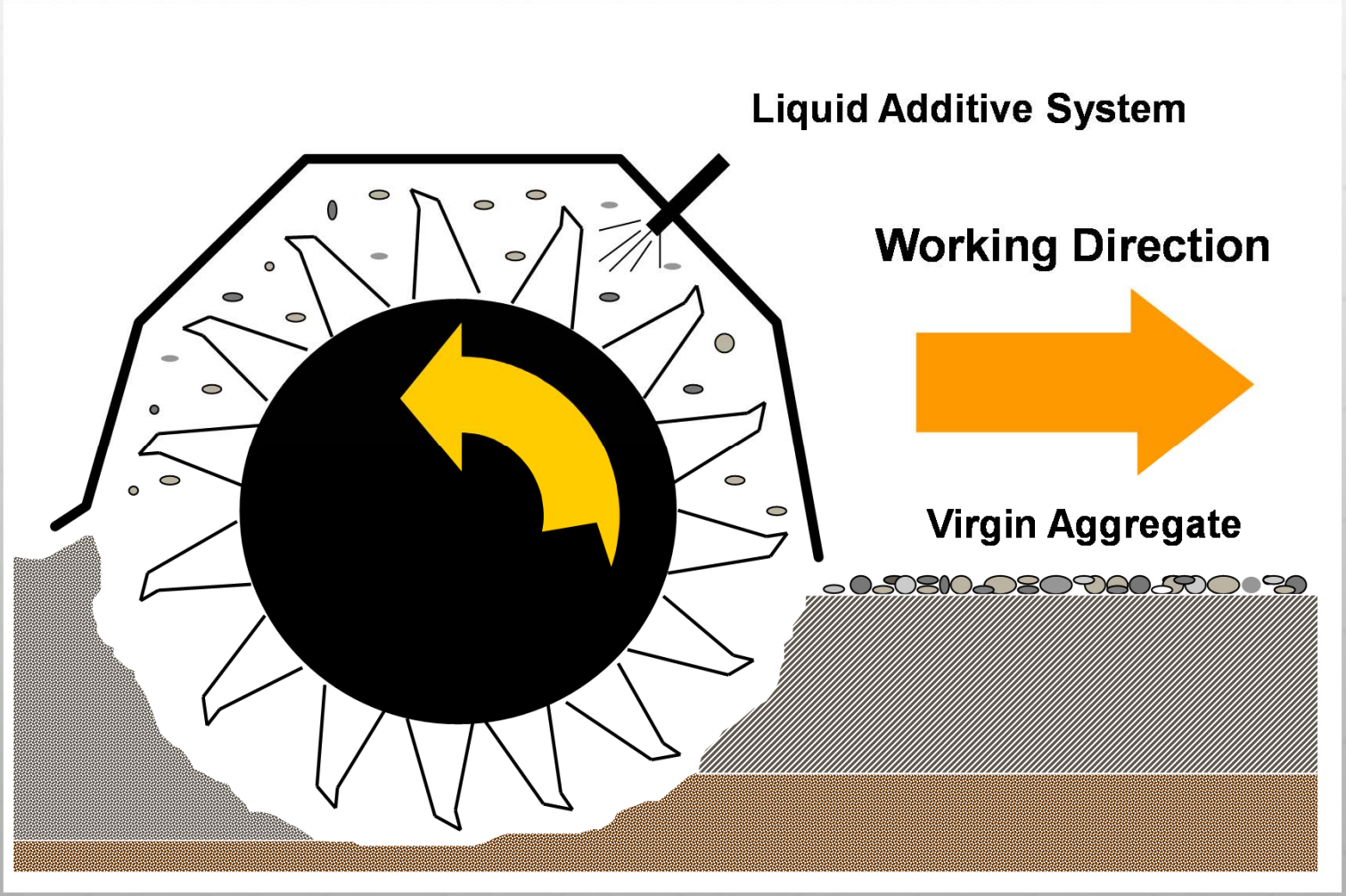
FDR Process

- **Supplemental Equipment**
  - **Dump Trucks/Stone Spreader**
  - **Asphalt Distributor/Tanker**
  - **Bulk Pneumatic Tankers**
  - **Calibrated Spreading Units**
  - **Slurry Equipment**

FDR Process

- **Construction Sequence**
  - **Varies based upon scope of project and stabilizers being used**
    - **Single Pass Reclamation**
    - **Multiple Pass Reclamation**

Single Pass Reclamation



Single Pass Reclamation

- Pulverize the existing pavement and underlying layers, simultaneously add and mix various stabilizing additives, if needed.
- Fine grade and compact the SBC.
- Fog seal or prime the SBC, as required.
- Apply the specified surface treatment.

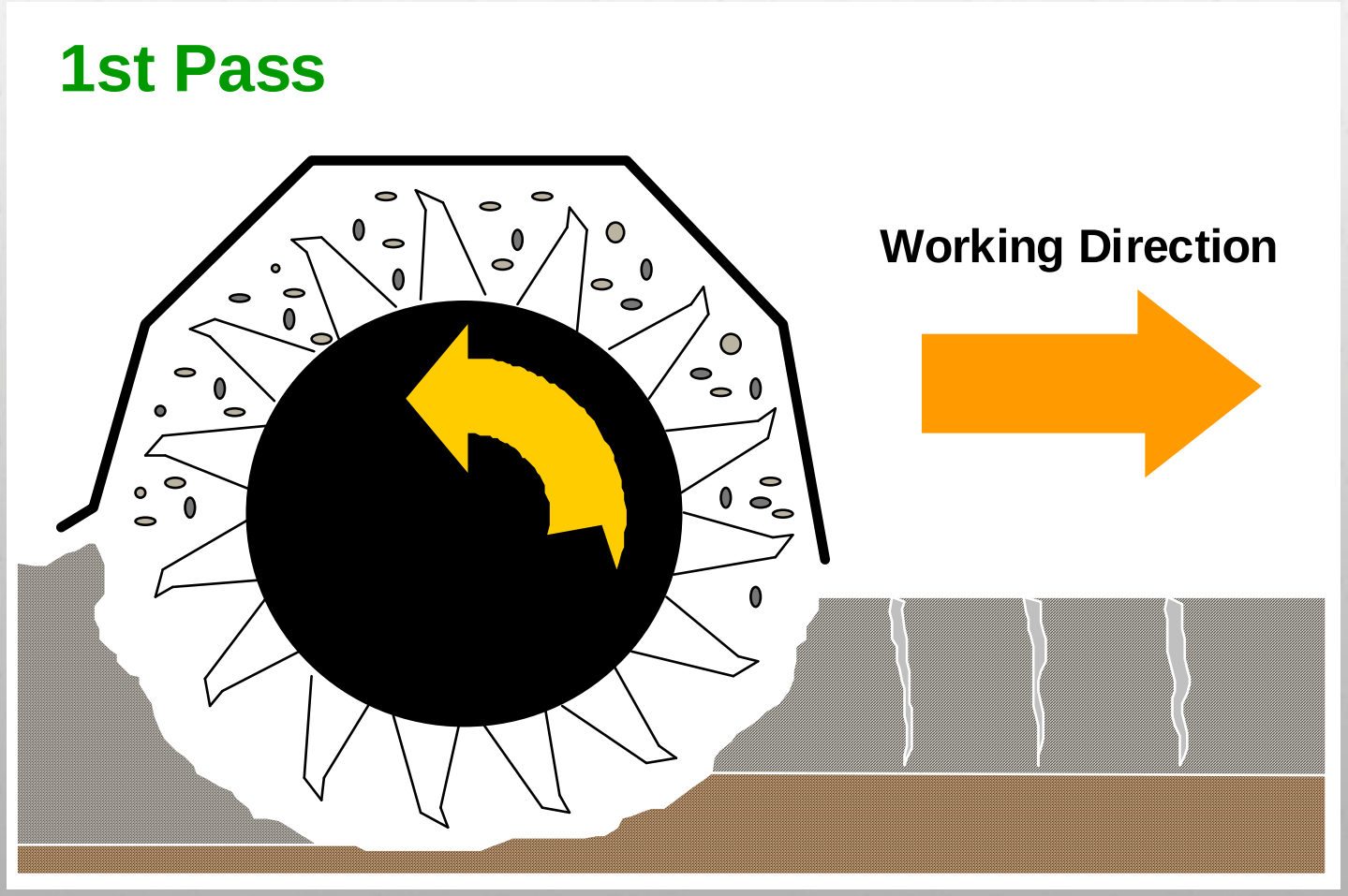
Single Pass Reclamation

- **Typically used when -**
  - **Performing simple pulverization**

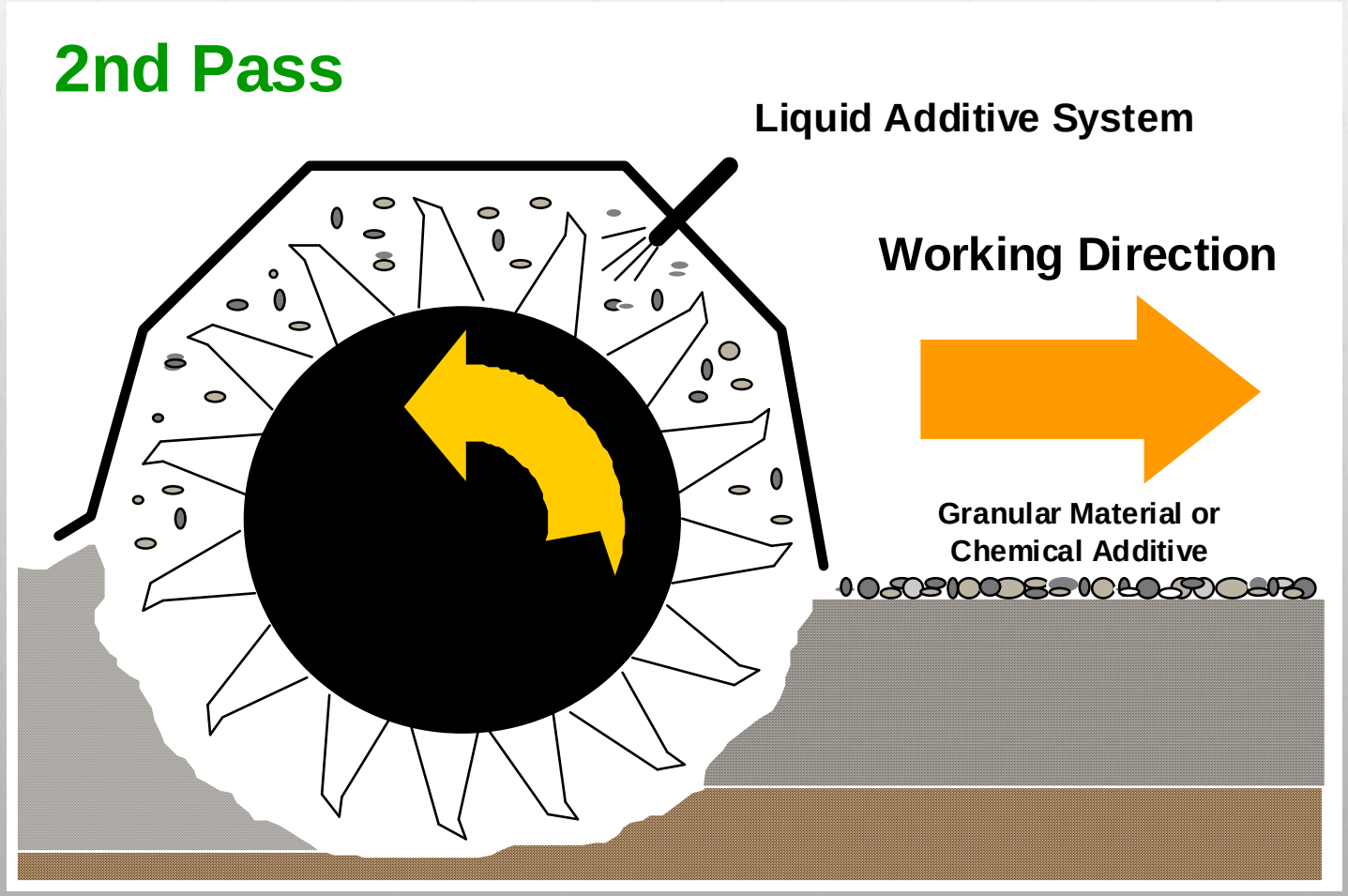
    (No stabilizing additives are being used)
  - **Existing asphalt is relatively thin**

    (6” or less), when using stabilizing additives
  - **Major cross-slope/profile grade corrections are not necessary**

Multi-Pass Reclamation



Multi-Pass Reclamation



Multi-Pass Reclamation

- Pulverize the existing pavement and underlying layers
- Pre-shape and compact the pulverized material
- Apply and mix stabilizing additives (2nd Pass)
- Fine grade and compact the stabilized material
- Fog seal or prime the SBC, as required
- Apply the specified surface treatment

Multi-Pass Reclamation

- **Typically used when –**
  - **Major cross-slope/profile grade corrections are necessary**
  - **Widening is being done (trenches)**
  - **Existing asphalt is thick (6” or more)**
  - **1 or more stabilizing additives are being used**

Compaction is Critical !!

- **Always part of the QA/QC Plan**

Compaction is Critical !!

- Typical Compaction Sequence
  - Initial (breakdown)
    - Single Drum Vibratory
    - Or Pad-foot Compactor

Compaction is Critical !!

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

Compaction is Critical !!

- Typical Compaction Sequence
  - Finish
    - Single or Double Drum Roller
    - Operating in Static Mode

The FDR Process

- 4 Primary Disciplines
  - Pulverization
  - Mechanical Stabilization
  - Asphalt Stabilization
  - Chemical Stabilization

Pulverization

- Most Economical FDR Discipline
- Accomplished with a single pass
- In-situ pavement layers and pre-determined amount of underlying materials are pulverized and mixed
- Moisture for achieving density is the only material added.
- NO STABILIZERS!

Pulverization

- Typically used when –
  - Base, sub-base and/or sub-grade deficiencies are not apparent
  - Anticipated quality of pulverized base course is sufficient enough to support the anticipated loads after surface course placement
  - Pulverized base course is acting as a sub-base for an engineered full depth pavement system.

Mechanical Stabilization

- Utilize pulverized asphalt pavement as an aggregate sub-base.
- Add aggregate (AASHTO # 3, 57, or 67) and mix to create a stronger sub-base

Mechanical Stabilization

- Involves the incorporation of imported granular materials
  - Crushed Virgin Aggregate
    - Coarse to Fine in Gradation
  - Reclaimed Asphalt Pavement (RAP)
  - Crushed Concrete (RPC)

Mechanical Stabilization

- **Can be performed in single of multiple passes.**

Mechanical Stabilization

- **Benefits**
  - **Improvement in the gradation of the reclaimed material - increased structural stability**
  - **The ability to lean in-situ materials containing high concentrations of asphalt, thereby increasing the mixture's structural stability**

Mechanical Stabilization

- **Benefits**
  - **Cross-slope and or profile grade corrections can be made without sacrificing section thickness by importing granular materials**
  - **Widening can easily be done without sacrificing section thickness**
  - **Can also be used in combination with other stabilizing additives - Bituminous or Chemical**

Mechanical Stabilization

- **Best used when –**
  - **Low to medium traffic volume pavements exhibiting the typical surface and minor base defects associated with an aged, oxidized and overloaded pavement**

Chemical Stabilization

- **Uses one or more of the following**
  - **Portland Cement (dry or slurry)**
  - **Lime - hydrated or quicklime (dry or slurry)**
  - **Fly Ash - Type “C” or “F”**
  - **Kiln Dust**
    - **Cement (CKD)**
    - **Lime (LKD)**
  - **Calcium Chloride**
  - **Other chemical products**

- Can be performed with a single pass or with multiple passes. Multiple passes are most common.

Chemical Stabilization

- **Additive application**
  - **Dry additives can be applied ahead of the reclaimer in dry powder form with calibrated spreading units, or can be disbursed in slurry form, either ahead of the reclaimer onto the pre-pulverized material, or through a suspension material spray bar integrated into the reclaimer's mixing chamber.**

Chemical Stabilization

- **The dry materials are used as cementitious or pozzalonic additives where strength is gained through the cementing of material particles and aggregates together in the reclaimed layer.**

Chemical Stabilization

- Strength gain is governed by the type of materials being stabilized, along with the type and amount of stabilizers used
- Too high a treatment can develop
  - Strengths that adversely affect the flexibility of the stabilized material
  - Decreased ability to manage repeated loading
  - Shrinkage cracking

Chemical Stabilization

- **Pozzalonic Stabilizers are suited to:**
  - **Low to High traffic volume pavements showing severe distress from loading due to insufficient base, sub-base and/or sub-grade materials**
  - **Low to medium volume - stabilized material**
  - **Typically used as base**
  - **High volume - stabilized material**
  - **Typically used as sub-base**
- **Typically performed at a 9” minimum thickness and best suited for (depending on the stabilizers being used) granular, silty or clay materials with a Plasticity Index (PI) greater than 6.**

Chemical Stabilization

- **Benefits**
- **Allows otherwise unsuitable on-site materials to be turned into strong, structural base or sub-base material.**
- **Pavements rehabilitated with chemical stabilization (Pozzalonic) typically require large amounts of full depth repairs or undercuts, or total reconstruction.**
- **Substantial savings.**
- **Less construction time.**

Chemical Stabilization

- **Additive application**
  - **Liquid Calcium Chloride or other liquid stabilizing additives can be applied ahead of the reclaimer onto the pre-pulverized material, or can be injected through the reclaimer's computerized additive system**

Chemical Stabilization

- **In Calcium Chloride's case, although some strength gain through the cementing of fine particles is achieved, the larger result is the lowering of the reclaimed layer's freezing point, thereby helping to reduce cyclic freeze/thaw in the layer**

Asphalt Stabilization

- **Types of asphalt stabilizing additives**
  - **Emulsified Asphalt**
  - **Foamed/Expanded Asphalt**
    - Can be performed with a single or multiple passes
    - Multiple pass = more consistent injection when in thick or irregular pavement

Asphalt Emulsion

- **Emulsified Asphalt Types**
  - **Anionic**
    - **High float**
    - **Polymer Modified**
    - **HFPM**
  - **Cationic**
    - **Standard**
    - **Polymer Modified**
    - **Chemically Controlled Break**

Asphalt Emulsion

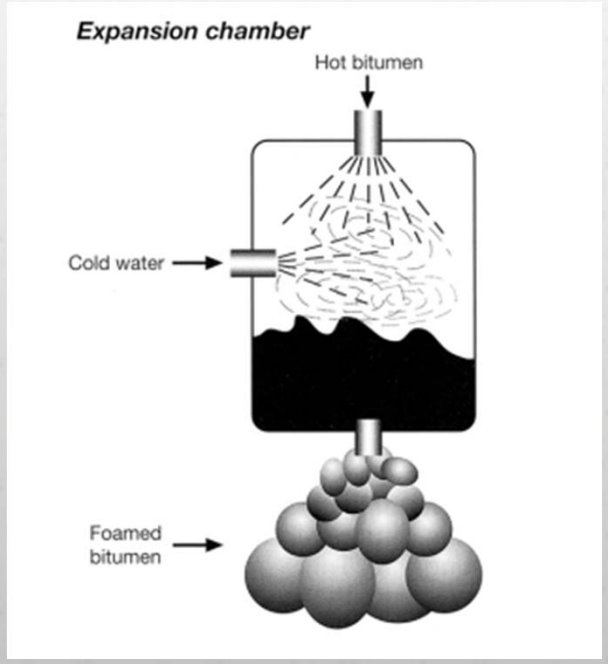
- Typical Composition
  - 60-65% residual asphalt cement
  - 35-40% water, emulsifiers & chemicals
- Need to allow for break/cure
  - Break is the point at which the water fraction dissipates, or is lost by some means, and the bitumen droplets rejoin, thereby converting to a continuous film and coating the reclaimed material particles

Asphalt Emulsion

- Factors that influence cure time
  - Atmospheric conditions
  - Internal chemical composition and characteristics of the emulsion
  - Water evaporation or loss of moisture through reclaimed material absorption
  - External pressures from mixing, grading and compaction processes
  - Chemical catalysts such as Portland cement or lime

Foamed/Expanded Asphalt

- **How is it made?**
  - **Elevated temperature asphalt cement (~320°F) is injected with a small amount of cold water (~2% by mass of AC)**
  - **The resulting thermal reaction greatly increases the surface area/volume of the AC, thereby decreasing its' viscosity and allowing for improved coating of fine materials**
  - **Handles high fines contents more readily than emulsion**
  - **Decreased cure time**
  - **Requires a minimum of 5% fines P200 sieve**



NOTE: Water added at this point for foaming/expansion evaporates immediately and can not be considered part of the mixture. Additional moisture must be added to aid in compaction if the reclaimed material moisture level is low

Bucket of Foam from Reclaimer

Foamed/Expanded Asphalt

- **Differences from Emulsions**
  - **Use straight AC - No manufacturing costs incurred other than initial cost of foaming apparatus**
  - **Handles high fines contents more readily than emulsion**
  - **Decreased cure time**
  - **Requires a minimum of 5% fines passing the #200 (0.075mm) sieve**

NOTE: May need to import special fine aggregate or Portland cement or lime to increase the P200 fraction

Asphalt Stabilization

- **Benefits**
  - **Cost effective method of improving the strength of a reclaimed material while reducing the effects of moisture**
  - **More flexible than other base course materials and chemical stabilizers, offers superior fatigue resistance, and is not prone to cracking**
  - **Works well in combination with other additives such as virgin or recycled granular material and/or cement or lime (dry or slurry)**

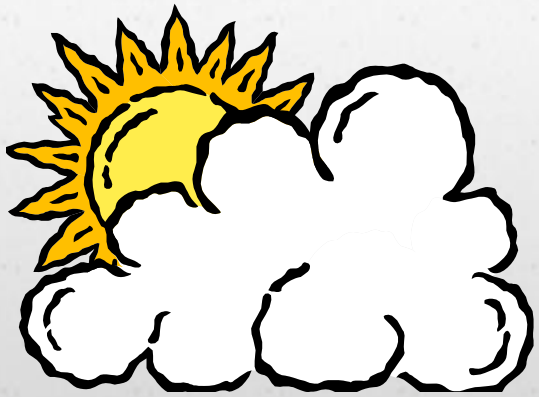
Asphalt Stabilization

- **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**
- **Material should consist of:**
  - **100% RAP or a blend of RAP and underlying granular base/sub-base or non-plastic/low plasticity soils**
  - **Plasticity Index (PI) less than 6**
  - **25% max passing the #200 sieve**

Mix Design – QA/QC

- Critical to know composition and thickness of existing pavement and base/sub-base layers
- Test borings and/or core samples accompanied by soil survey information is important when trying to determine proper reclamation technique

Weather Limitations



- **Based on Type of Additive Used**
- **Pulverization or Mechanical**

  less restrictive
- **Bituminous or Chemical**

  more restrictive

Before Surface Treatment

- Don’t Trap Moisture in the SBC
- Depending on Stabilizers Used, Normal Curing takes 3-7 days prior to Surface Treatment
- Predetermined SBC Moisture Content may be Specified Prior to Applying Surface Course

Typical Surface Treatments

- Chip Seal
- Slurry Seal
- Micro-Surfacing
- Cape Seal
- Cold Mix Overlay
- Hot Mix Overlay

Benefits

- Completely erases deep pavement crack patterns, thereby eliminating the potential of reflective cracking.
- FDR can be utilized to depths exceeding 16”. (6”to 12” typical)

Benefits

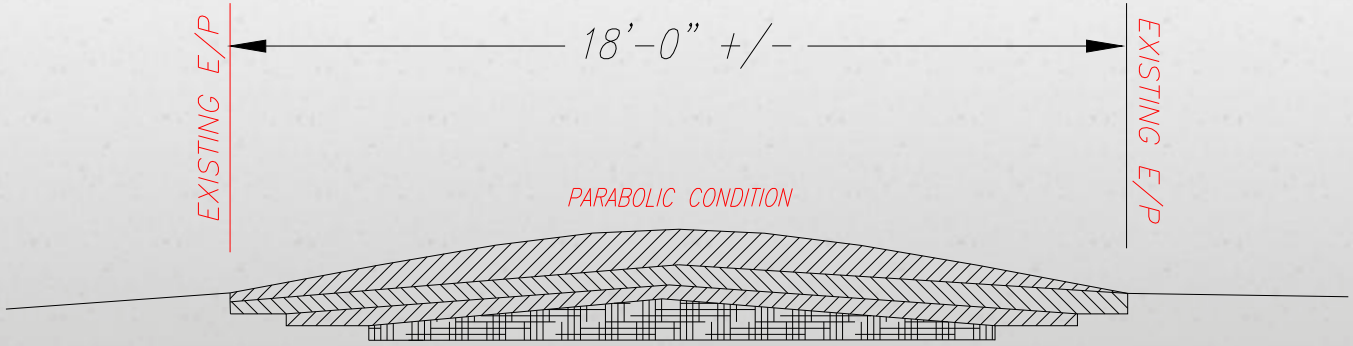
- **Pulverized layers along with stabilizing additives become a homogenous, well graded material with improved structural characteristics.**

Benefits

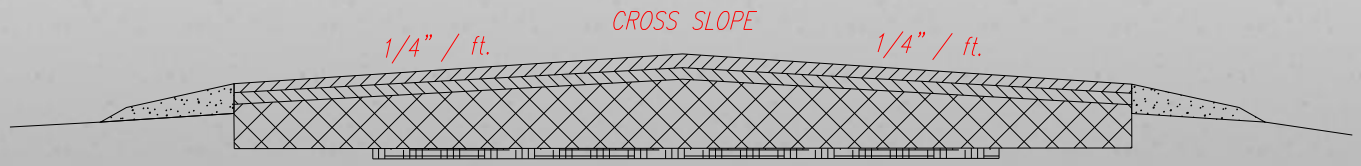
- With proper design and process selection
  - Profile and cross slope can be adjusted.
  - Widening can easily be accomplished.

Benefits

- **Profile and cross slope can be adjusted.**



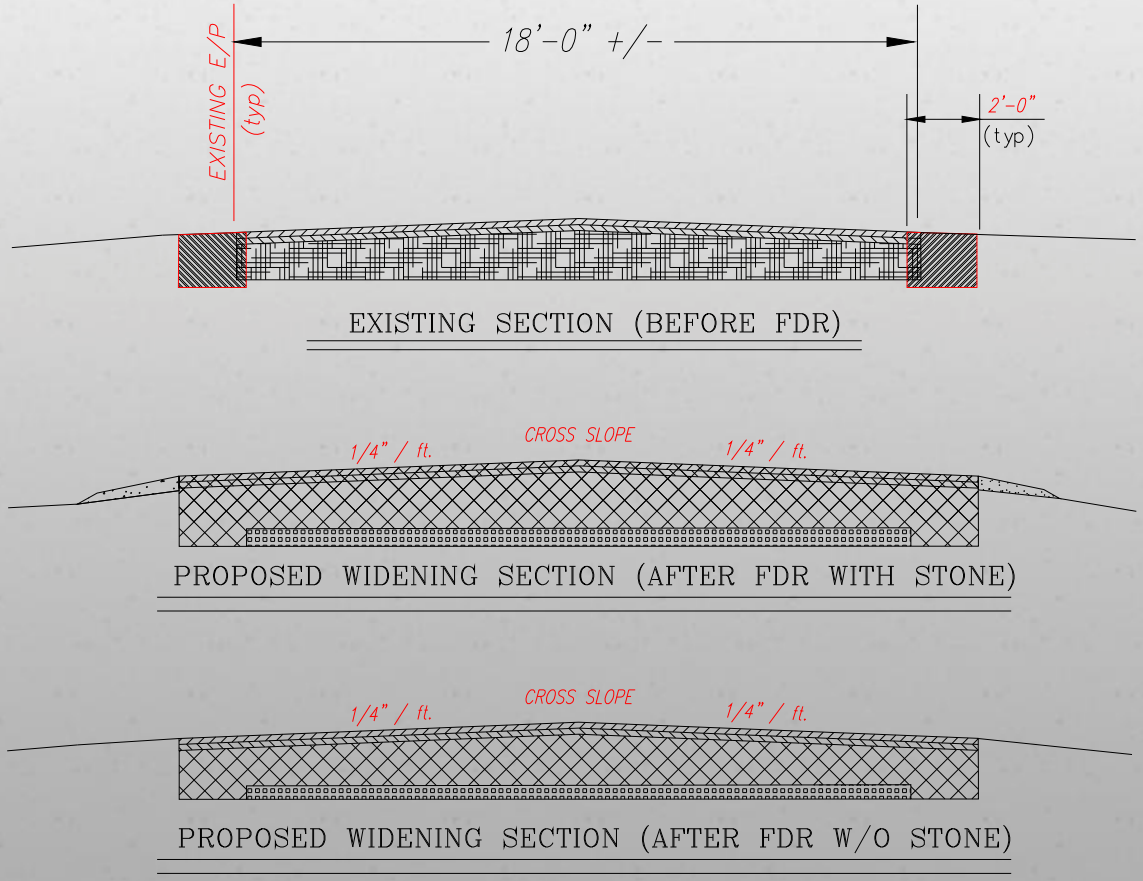
EXISTING SECTION (BEFORE FDR)



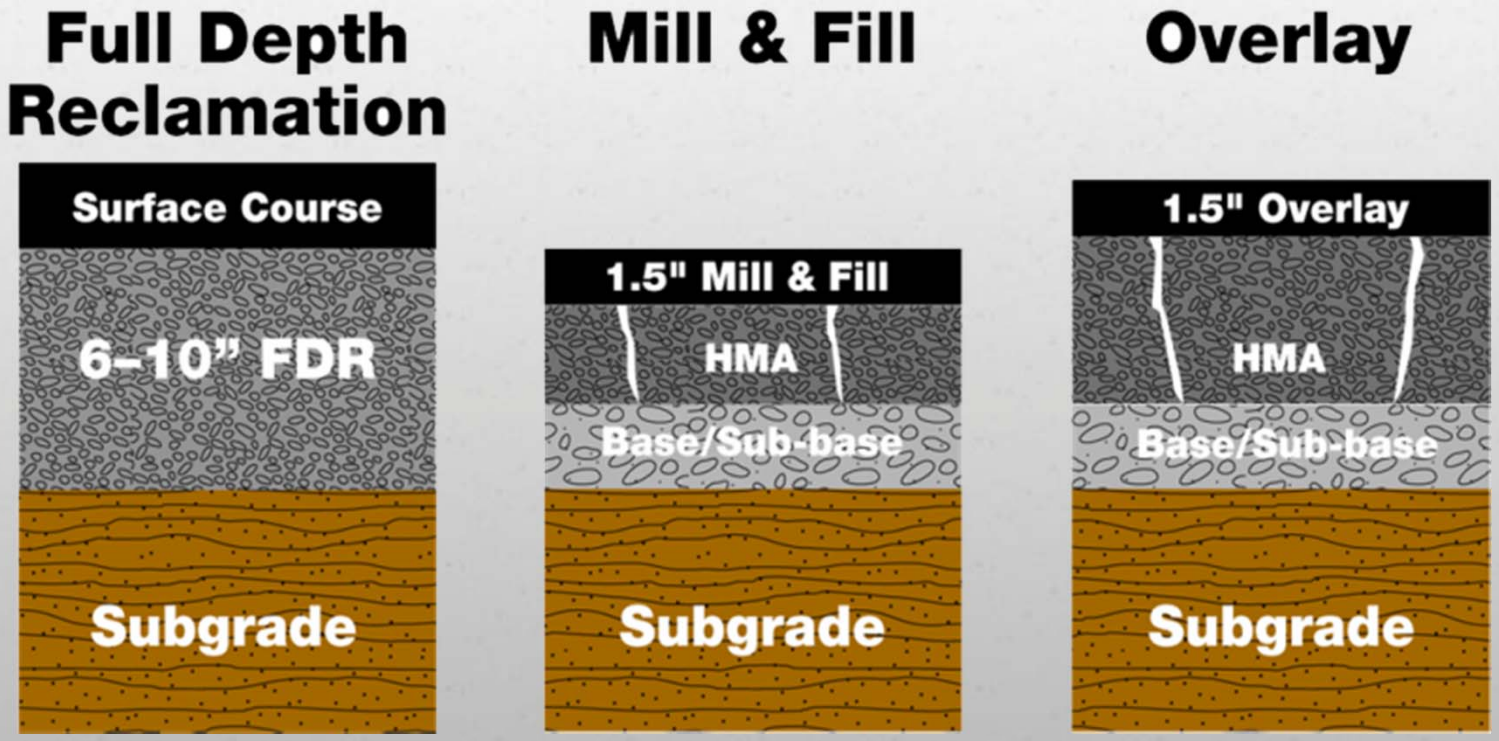
PROPOSED SECTION (AFTER FDR)

Benefits

- **Widening can be easily accomplished**



Benefits


Full Depth Reclamation
Surface Course
6–10” FDR
Subgrade
Mill & Fill
1.5" Mill & Fill
HMA
Base/Sub-base
Subgrade
Overlay
1.5" Overlay
HMA
Base/Sub-base
Subgrade

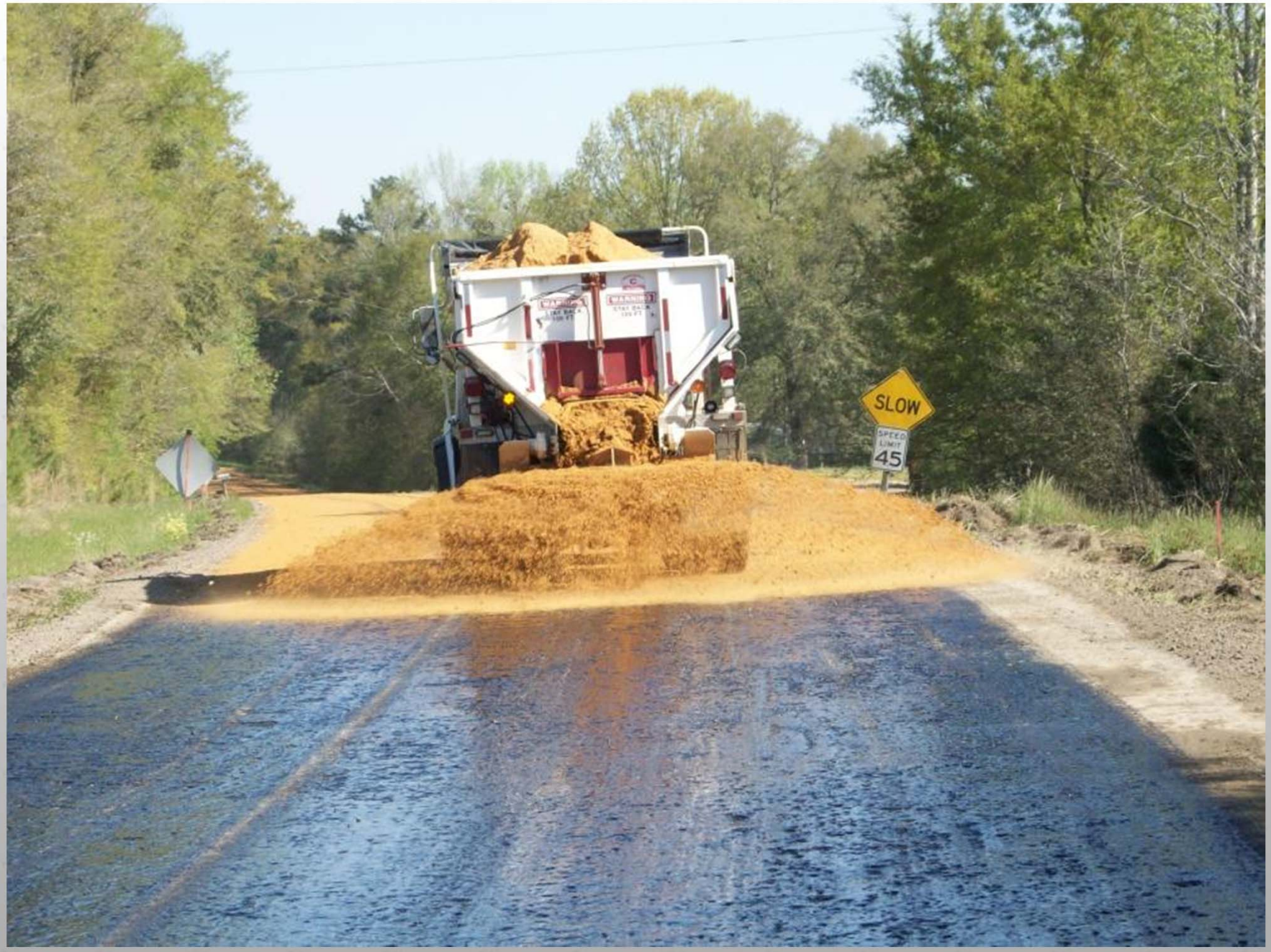
FDR Summary

- **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 easily restored**
- **Loss of Curb Reveal is Eliminated**
- **Reflective Cracks Eliminated/Reduced**
- **Long-term Cost Effective – the cause of pavement failure, weak bases, is addressed.**
- **Environmentally Desirable – recycling in-place is much more efficient than hauling materials away their for saving time and money.**
- **Future Maintenance Costs are Reduced.**

Traffic on job

Cement FDR in Tuscaloosa County Al.


CATERPILLAR


SLOW
SPEED LIMIT
45

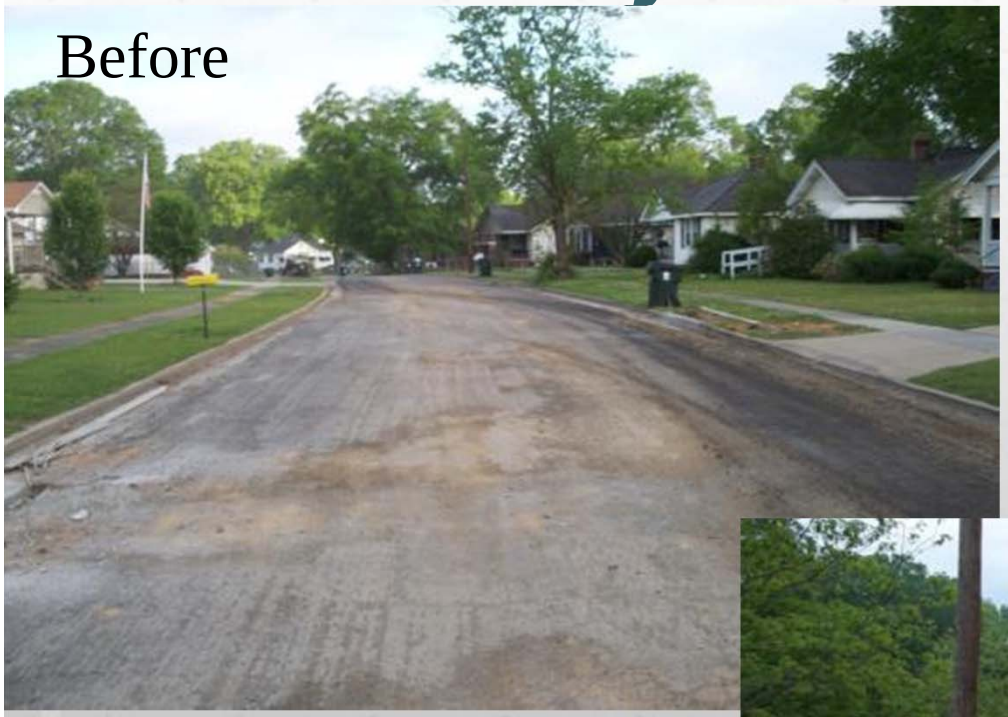
Foam Asphalt job in Ga. work done Nov. 2005


01/27/2011

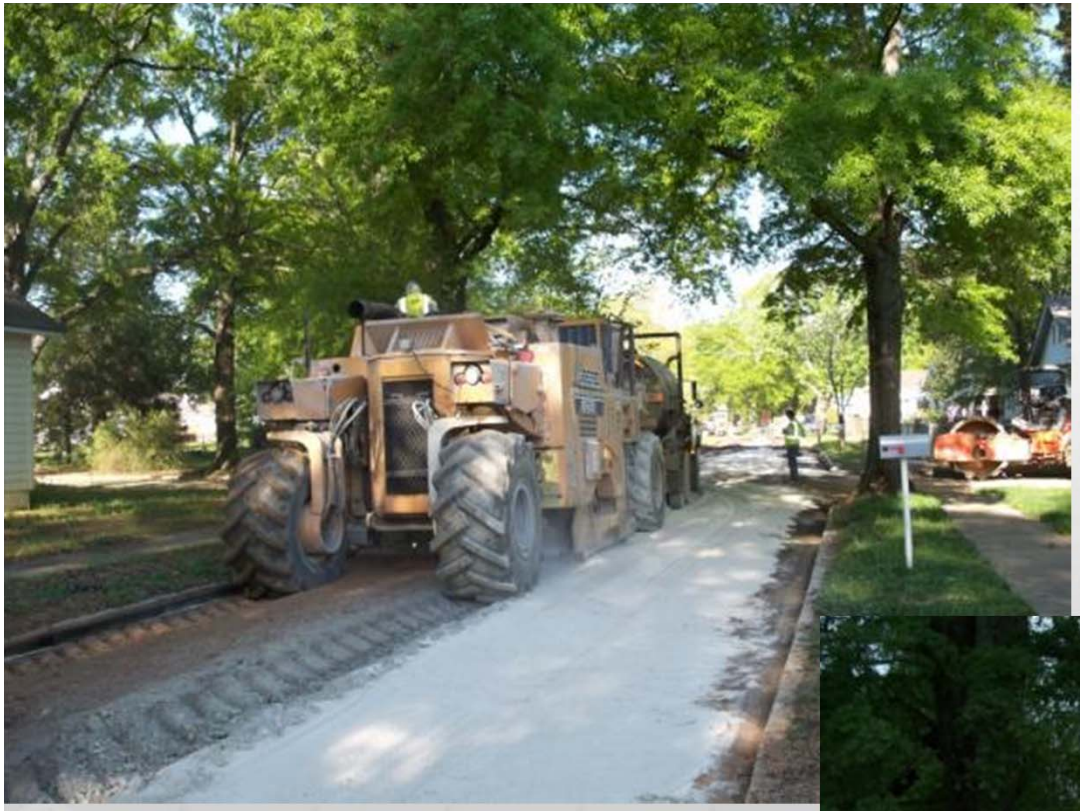

35
01/27/2011

LKD FDR job in Rockmart Ga.

Before

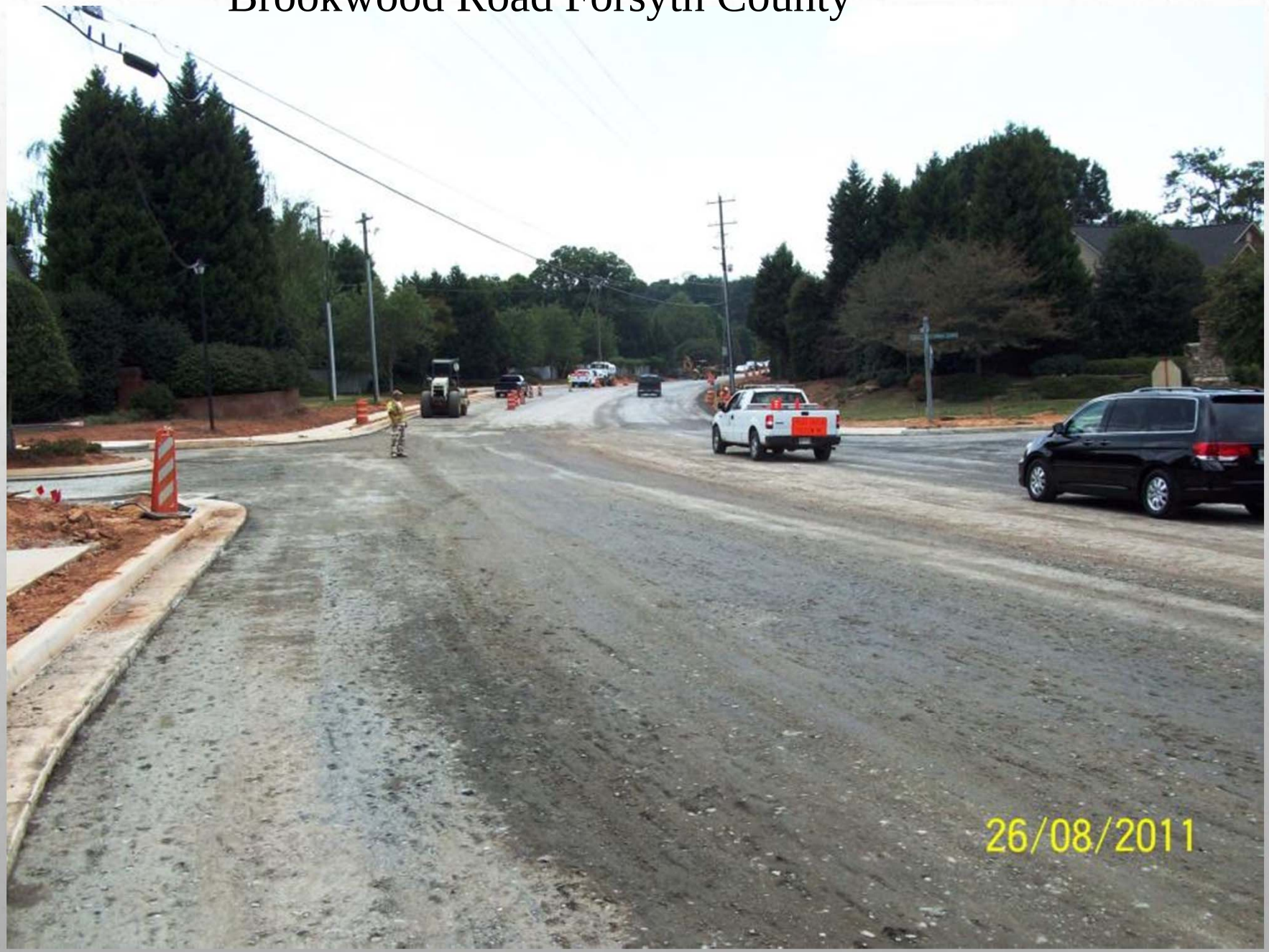


After FDR
Paving Started




STOP

Brookwood Road Forsyth County




26/08/2011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Questions ???