Overview & Progression of Pavement Recycling

Pavement Recycling Reclaiming Center

Virginia Pavement Recycling Conference

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Stephen A (Steve) Cross, PhD, PE

Professor, Oklahoma State University

Executive Director

Pavement Recycling & Reclaiming Center

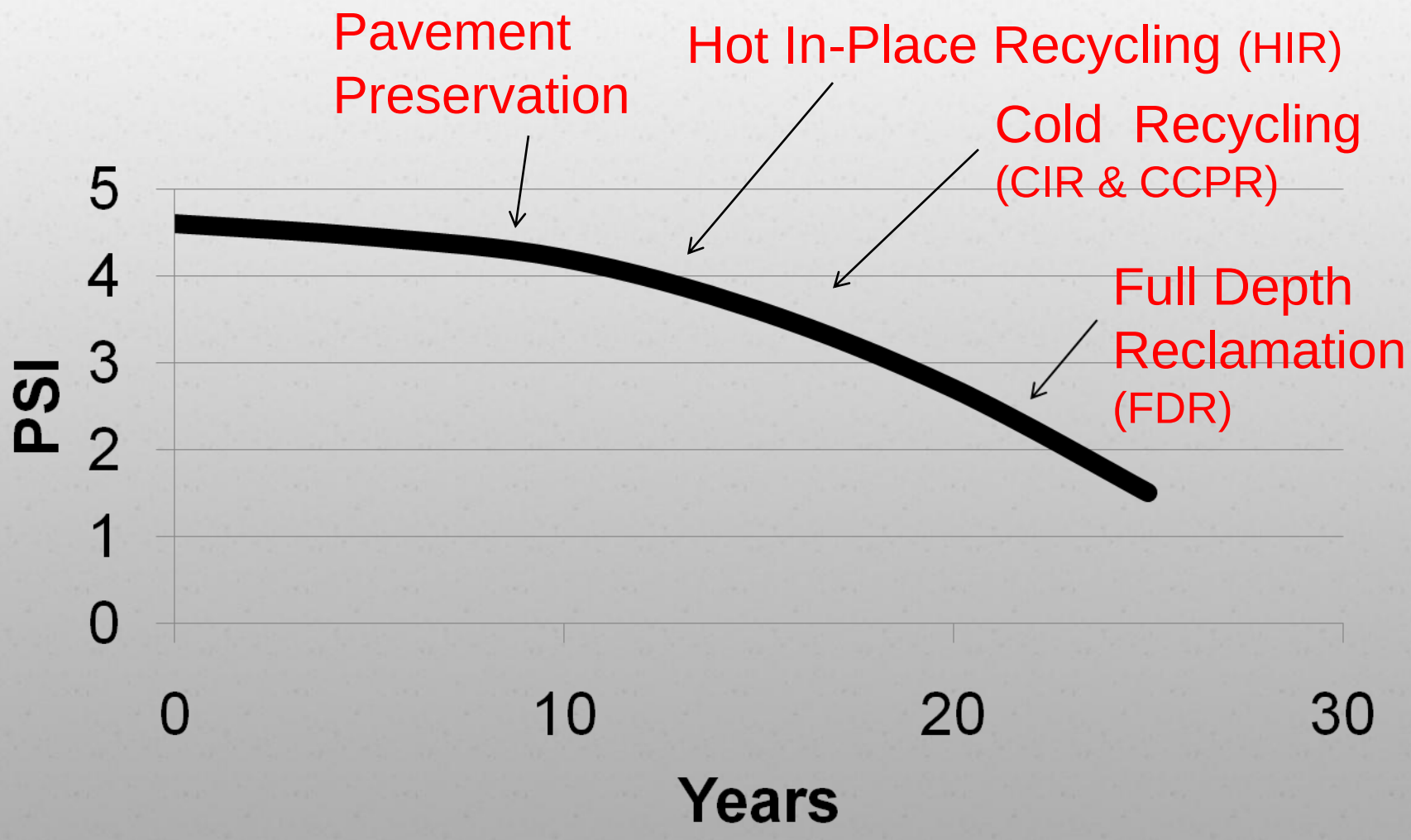
ARRA

- Asphalt Recycling & Reclaiming Association www.ARRA.org
- Industry Segments
  - Cold Planing
  - ***Hot In-Place Recycling***
  - ***Cold Recycling***
  - ***Full Depth Reclamation***
  - Soil Stabilization
  - Hot Recycling

In-Place Recycling

- **Briefly review ARRA's major core areas of in-place recycling:**
  - **Hot In-Place Recycling (HIR)**
  - **Cold Recycling (CR)**
  - **Full Depth Reclamation (FDR)**

Pavement Management



Recycling & Reclaiming Strategies

M&R	Strategy	Method	CP	HIR	CR	FDR
Construction	New					
	Reconstruction		X			X
Rehabilitation	Major		X		X*	X
	Structural Overlay		X	X*	X*	X*
	Minor	pp	X	X	X	
Maintenance	Preventative	pp	X	X	X	
	Routine	pp	X			
	Corrective		X	X	X	
	Catastrophic		X			

*With HMA Overlay

PP = Pavement Preservation

Hot In-place Recycling

- **HIR uses heat to soften the existing asphalt cement, mills or scarifies the pavement, adds recycling agent and additives (if desired), relays and compacts the pavement in one continuous process.**

HIR Candidates

Aging of asphalt pavement occurs most rapidly at the surface causing Ruts, Shoves, Bumps, Patches & Utility Cuts, Shrinkage Cracks, Weathering, Bleeding & Raveling

Modern Heating Equipment

Today's HIR equipment provides better heat to the pavement, allowing greater heat penetration while minimizing damage to the binder.

Recycling Agents

- Recycling Agents add properties to the existing asphalt which have been lost or retarded due to environmental effects.
- Normally Recycling Agents are produced from the crude refining process.
- They are introduced as Emulsions (ARA-1 designation)

3 Types HIR

Surface Recycling:

Heating, reworking and rejuvenating the top one-two inch of an existing asphalt pavement in preparation of either a seal coat, micro-surfacing or overlay

Repaving:

Heating, reworking and rejuvenating the top one inch of an existing asphalt pavement and simultaneously applying an overlay while the temperature of the recycled layer is 200°F

Remixing:

Heating, reworking and rejuvenating the top 1 to 2 inches of an existing asphalt pavement adding virgin aggregate and/or admix and mixing the newly recycled material in a pug mill mixing plant prior to laying, either as a binder or surface course

Surface Recycling

Heating, reworking and rejuvenating top 1-2 inches of existing asphalt pavement in preparation of wearing surface.

Surface Recycling – Milling/Scarifying

Surface Repaving

- **Heating, reworking and rejuvenating the top 1-2 inches of an existing asphalt pavement and simultaneously applying an overlay while the temperature of the recycled layer is > 200°F.**

  Results in 1 layer

Surface Remixing

Heating, reworking and rejuvenating the top 1 to 2 inches of an existing asphalt pavement adding virgin aggregate and/or admix and mixing the newly recycled mix material in a pugmill or drum mixing plant prior to laying, either as a binder or surface course.

HIR Placed Similar to HMA

Placement

Compaction

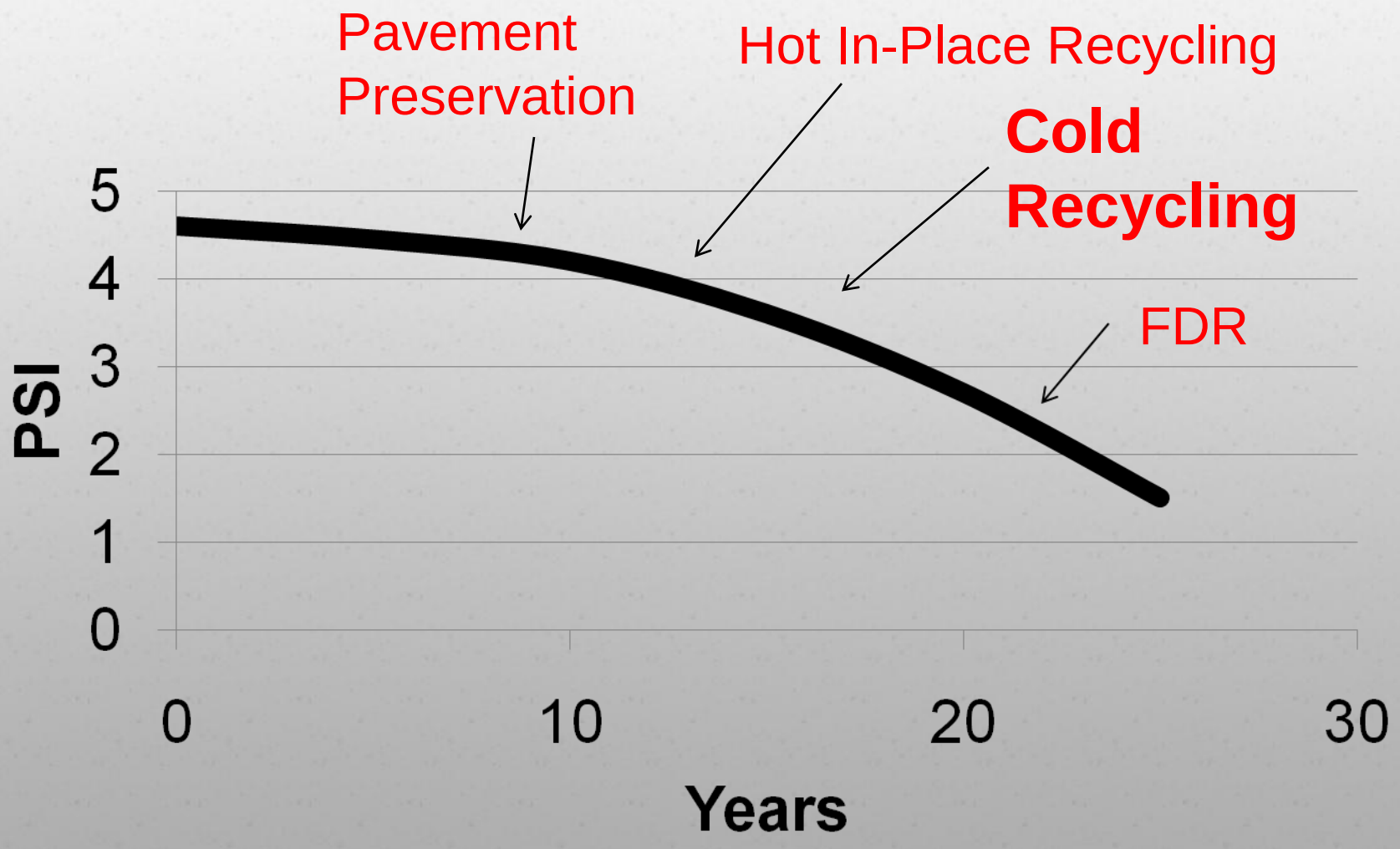
HIR Benefits

- Repairs Distress
- Extends Life
- Improves Ride Quality
- Eliminate need for a leveling course
- Improved Bonding
- Environmentally friendly
- Cost savings

Cold Recycling

- *A process whose time has come…*
  - *environmentally sound*
  - *gives enhanced performance*
  - *and saves dollars.*

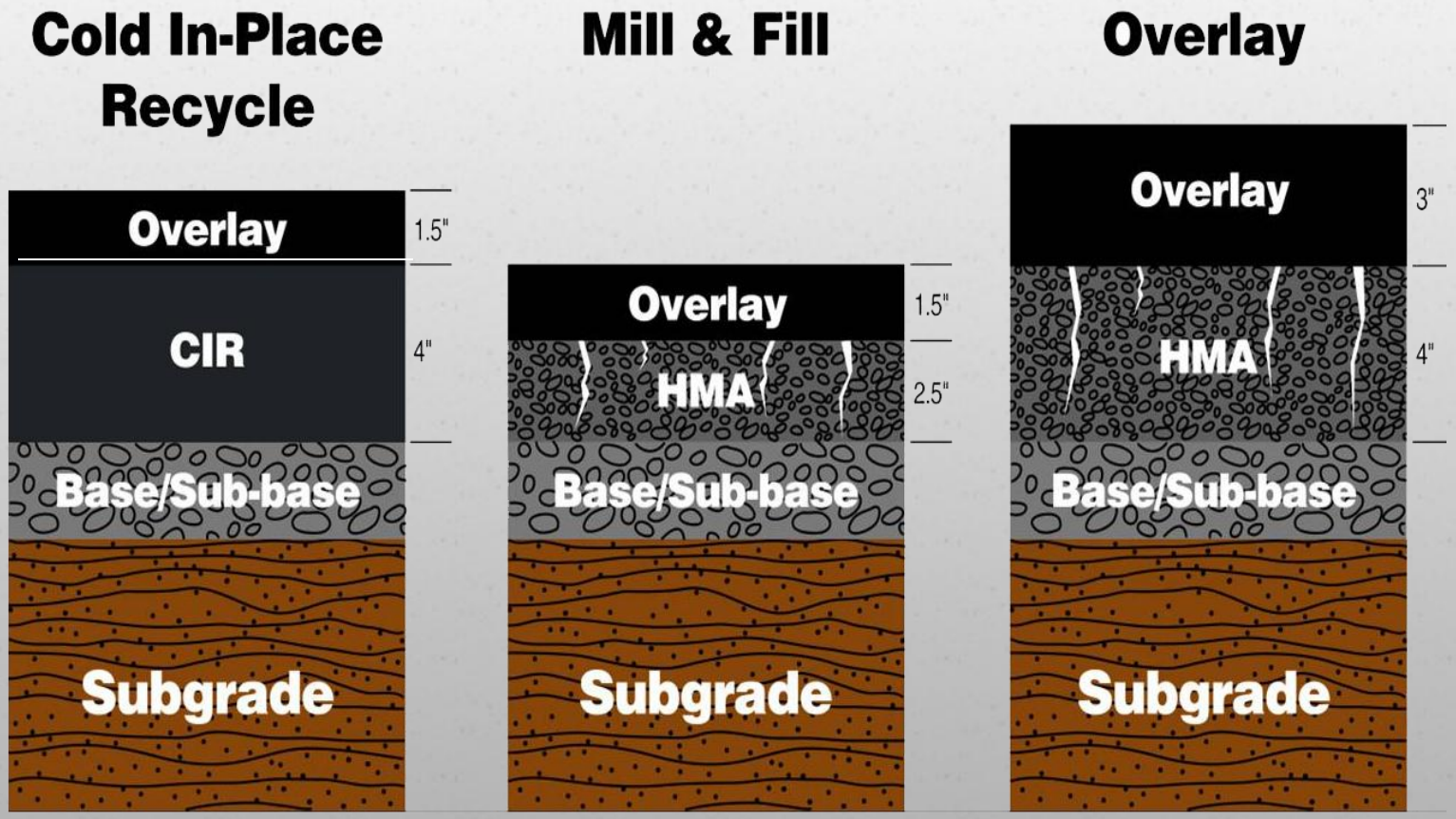
Pavement Management



CIR – Pavement Types

- Originally Limited to Low Volume Roads
  - County Roads
  - State Highways
- Now Used for:
  - Airport Runways
  - US Highways
  - Interstate Highways

Cold Recycling – Cross Section



25 to 50 percent savings over typical HMA Mill / Overlay

Types of Cold Recycling

- **Cold Central Plant Recycling (CCPR)**

- **Cold In-Place Recycling (CIR)**

Cold Central Plant Recycling

A viable alternative when stockpiles of high quality RAP are available or when it is not possible to in-place recycle the pavement. Requires different emulsion formulations.

CCPR - Applications

Immediate Lay. When the recycled cold mix is to be placed immediately a quicker setting emulsion may be used.

Stockpile Mix. Emulsion with cutters or rejuvenators may be used to enhance mix workability.

Partial Depth CIR

- CIR 2-5 inch Depth
- Definition: Restricted to Asphalt Pavement & Minor Amounts of Base
- CIR Repairs Functional Failures – cracking, raveling, pot holes, patches, poor ride quality
- Will not treat structural failures – major fatigue cracking, mix instability, wet or soft subgrades, drainage issues (use FDR)

CIR Process Description

- Pulverizing Existing Pavement
- Sizing of the Reclaimed Asphalt (RAP)
- Addition of new Binder/Additives
- Mixing all Component Materials
- Placement and Compaction of Mixture
- Placement of Wearing Surface

Partial Depth CIR Equipment

Multi-Unit Trains

2-Unit Trains

Single Unit Recyclers

CIR – Placement & Compaction

Traditional Asphalt Pavers Used

Heavy (25 ton) pneumatic roller(s) and a 10-12 ton steel wheel roller(s)

CR Recycling Agent Selection

- **Polymer Modified Emulsions**
  - Improved fatigue and thermal cracking resistance without reducing stability
  - HFMS-2P, HFE -150P
- **Solvent Free Emulsions (CSS) with Lime**
  - Improved early strength, quicker curing and improved moisture resistance
- **Engineered Emulsions**
  - Controlled curing/breaking
  - Formulated to Resist Raveling, Rutting, Moisture damage, Improved Crack Resistance
- **Expanded Asphalt (Foam)**

CR – Additive Selection

Chemical Additives:

- Portland Cement – Dry or Slurry
  - Min. 3:1 ratio residual asphalt to cement
- Hydrated Lime – Dry or Slurry (1-2%)
- Portland Cement & Hydrated Lime have been used in conjunction with asphalt emulsions and foamed asphalt to improve early strength, increase rut resistance and improve moisture resistance
  - Do not use with anionic emulsions

CIR – Additive Application

Slurry Application.

Portland Cement and Hydrated Lime may be applied in slurry form.

Dry Application.

Type C Fly Ash, Portland Cement or Hydrated Lime may be spread dry in front of the recycling train.

Wearing Course

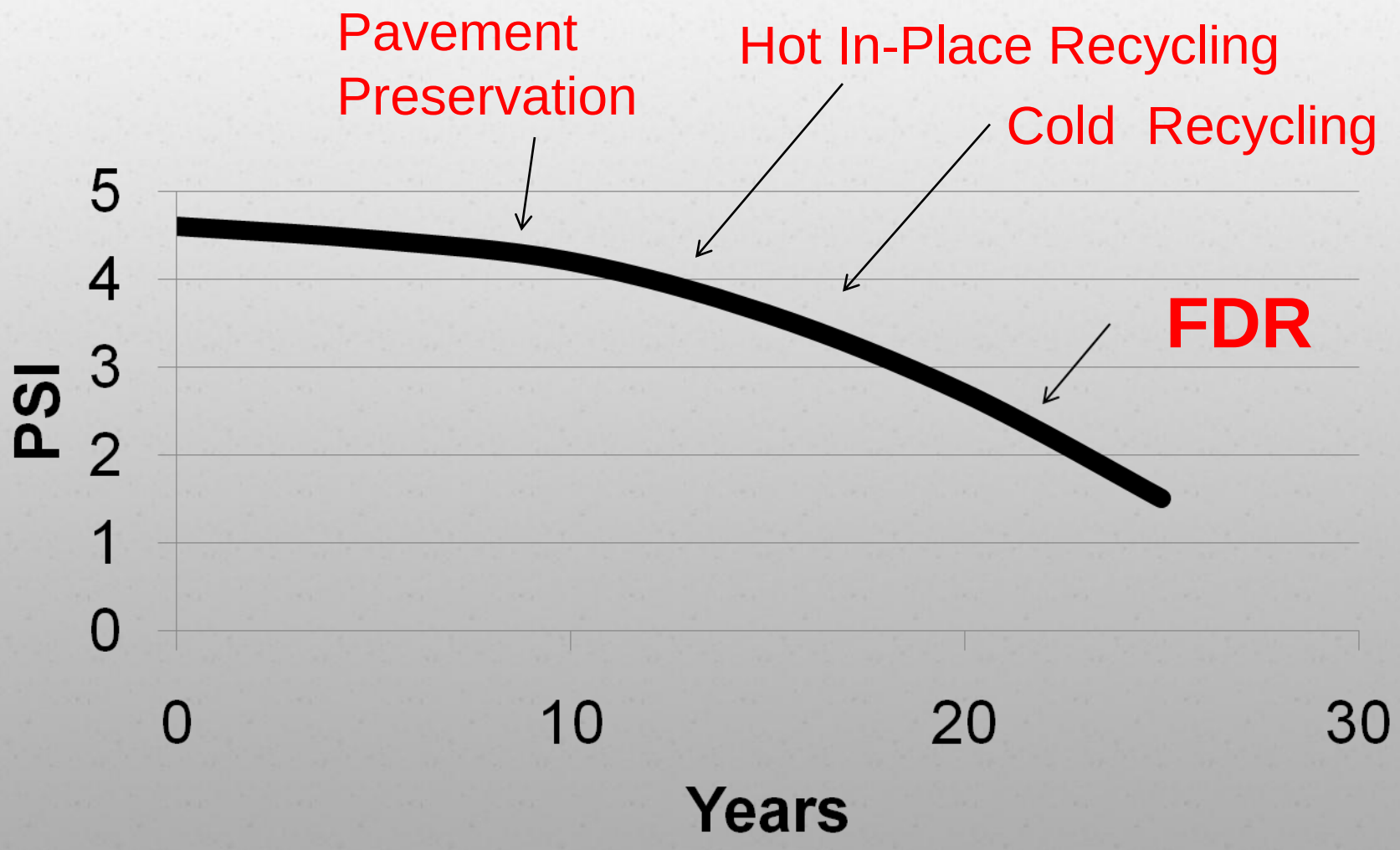
- Typical Thickness
  - Seals for Low Volume Roads
  - Minimum 1.5” HMA Med. Traffic
  - 3-4” HMA for High Traffic

CIR Advantages

- Conserves Energy
- Conserves Materials
- Improved Mix Characteristics
- Cracks Eliminated/Reduced
- Cost Effective
- Saves Time
- May Be Performed Under Traffic.

Full-Depth Reclamation

Pavement Management

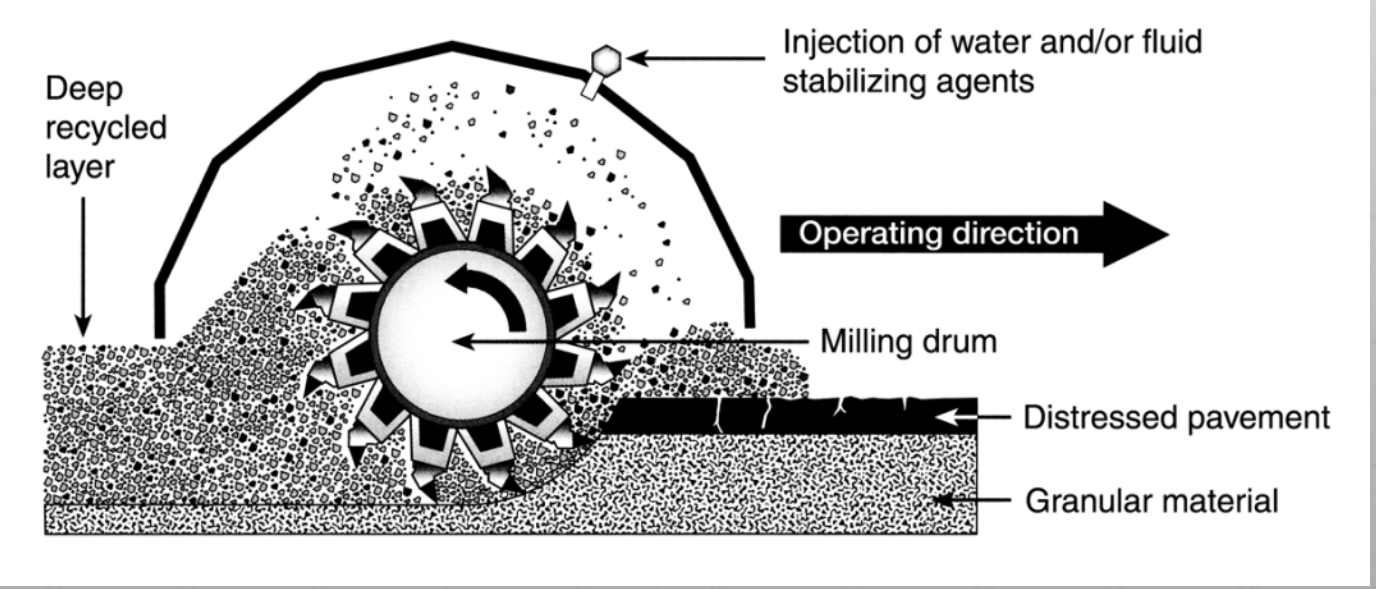


What is FDR?

- **A 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 additives.**

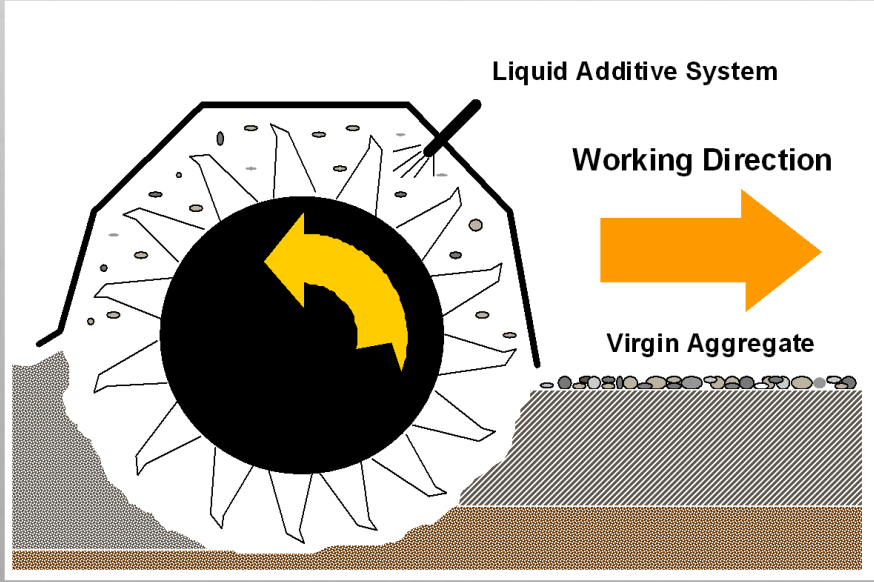
Comparison

- **FDR is distinguished from Cold 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 Process

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



FDR Process

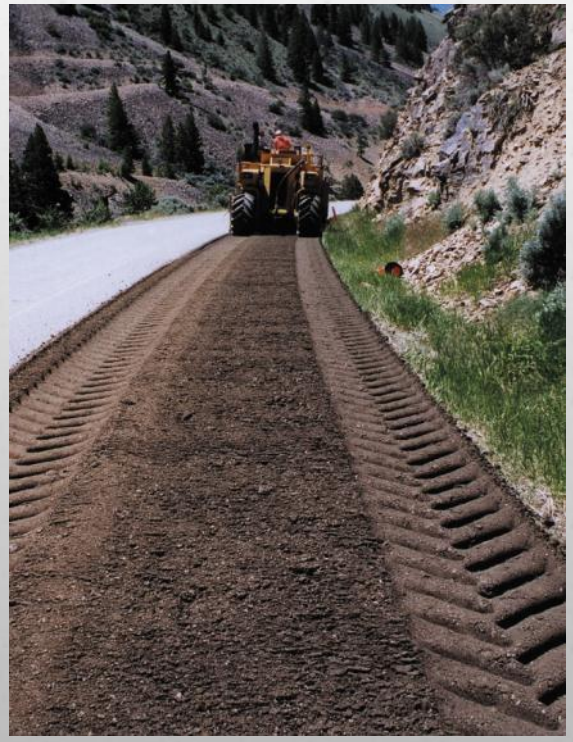
- **Single Pass -**
  - **Performing simple pulverization**
    (No stabilizing additives are being used)
  - **Existing asphalt is relatively thin**
    (6” or less), when using stabilizing additives
  - **Cross-slope/profile corrections not necessary**
- **Multiple Pass –**
  - **Cross-slope/profile corrections <u>are</u> necessary**
  - **Widening is being done (trenches)**
  - **Existing asphalt is thick (6” or more)**
  - **1 or more stabilizing additives are being used**

Compaction is Critical

- Initial (breakdown)
  - Single Drum Vibratory
  - Pad-foot Compactor
- Intermediate
  - 25-30 Ton Rubber Tire Roller
  - Single or Double Drum Vibratory Compactor
- 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!

MECHANICAL STABILIZATION

- **Involves the incorporation of imported granular materials (Aggregates or RAP)**
- **Utilize pulverized asphalt pavement as an aggregate sub-base**
- **Can be performed in single or multiple passes**

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

- **Dry Application**
  - **Applied ahead of the reclaimer with calibrated spreading units**
- **Slurry Form**
  - **Applied either ahead of the reclaimer onto the pre-pulverized material, or through a spray bar integrated into the reclaimer's mixing chamber.**

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

Asphalt Stabilization

- **Incorporates asphalt stabilizing additives**
  - **Emulsified Asphalt**
  - **Foamed/Expanded Asphalt**

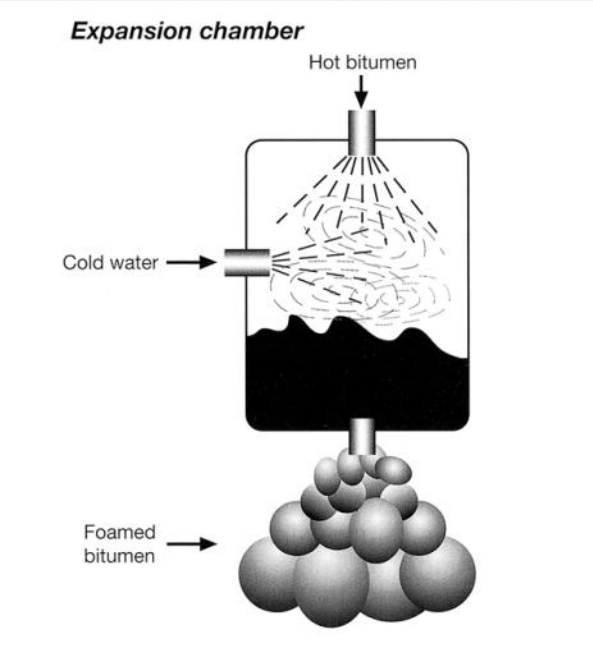
- **Can be performed with a single or multiple passes**
- **Multiple pass = more consistent injection when in thick or irregular pavement**

Asphalt Emulsion Types

- Anionic
  - High float
  - Polymer Modified
- Cationic
  - Standard
  - Polymer Modified
- Engineered Emulsions
  - Chemically Controlled Break

Foamed/Expanded Asphalt

- Hot 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

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)**

FDR Summary

- Conserves Energy
- Conserves Materials
- Crown and cross-slope easily restored
- Loss of Curb Reveal is Eliminated
- Reflective Cracks Eliminated/Reduced
- Long-term Cost Effective
- Environmentally Desirable
- Future Maintenance Costs are Reduced.

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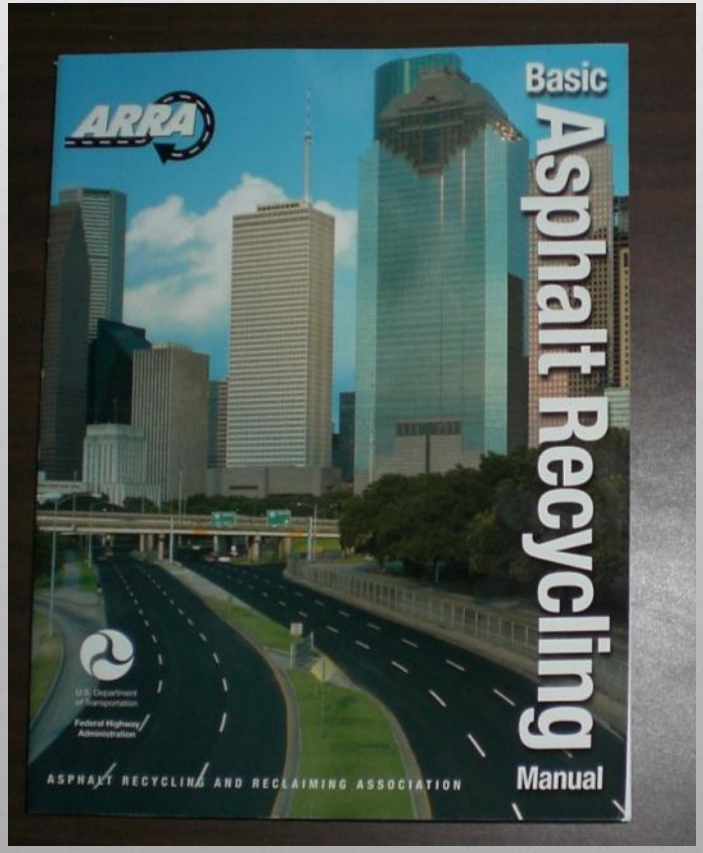
2nd Edition



- **Guidelines for:**
  - **Construction**
  - **Mix Design**
  - **QA Sampling & Testing**
  - **Project Selection**
- **Steve Cross, PhD, PE**
  - **steve.cross@okstate.edu**
  - **405-744-7200**

ARRA Cold Planing