Update on Pavement Recycling

2023 Alaska Asphalt Paving Summit

Anchorage, Alaska

November 6, 2023

Jason Wielinski, P.E.

Regional Engineer

Who is ARRA?

ARRA™

Responsible Renewal. Reliable Results.

- Asphalt Recycling and Reclamation Association
- Association comprised of:
  - Contractors (34)
  - Suppliers (30)
  - Affiliates (21)
  - Equipment Dealers (2)
  - Consulting Engineers (14)
  - Agencies (42)

- ***Free*** membership for agencies!
  - www.ARRA.org
  - Resources and Training Materials

The Need Everywhere

ARRA™

Responsible Renewal. Reliable Results.

Dwindling Budgets +

Dwindling Resources +

Demand for Sustainable Technologies +

Demand by Public for Safe, Quality Pavements

=

Need for Alternative Methods

In-Place Recycling Helps Meet the Challenge

- Reuses 90-100% of existing materials, in-place
- Costs 20-50% less than traditional methods
- Produces up to 90% less greenhouse gasses
- Reduces user delays
  - 20 to 40% faster construction
- Proven Performance

ARRA Disciplines

- Cold Planing (CP)
- Hot In-place Recycling (HIR)
- Cold Recycling (CR)
  - Cold In-place Recycling (CIR)
  - Cold Central Plant Recycling (CCPR)
- Full Depth Reclamation (FDR)
  - Soil & Base Stabilization

Cold Planing

ARRA™
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- Surface or grade preparation for other rehabilitation techniques
- Temporary driving surface
- Improving ride quality
- Fine & Micro Milling

Hot In-place Recycling

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- HIR uses heat to soften the existing asphalt pavement
- Scarifies the heated, softened pavement (1 – 3 inches)
- Add rejuvenating agent and additives (if desired)
- Mix and place rejuvenated mix
- Compact pavement in one continuous process.
- Usually requires surface course

Cold Recycling

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- Cold Central Plant Recycling (CCPR)

- Cold In-Place Recycling (CIR)
  - Also called partial depth cold in-place recycling

Cold Central Plant Recycling

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- **Clean Rap = New Pavement:**

- Stockpiled and kept clean
- Crushed RAP to gradation
- Produced at a central location using a central mixing plant
- Fractionating of RAP and adding new aggregates is possible
- Mixed with bituminous recycling agent in central plant
- Transported to lay down area
- Paved as a recycled mix
- Compacted to specified density
- Readied for surface treatment

From RAP

to Pavement

Cold In-place Recycling

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- Removes, crushes and sizes existing pavement (without heat) at depths of 3 -5 inches
- Mixes stabilizing agents (and additives) with RAP
- Places recycled mix with traditional paving equipment
- Compacts pavement in one continuous process.
- Requires surface course after curing

- Single Unit
- Mixing and sizing done in cutter housing
- Additive calculated on volume

- Multi-Unit
- Closed loop sizing with screen and crusher
- Additive by weight

Full Depth Reclamation

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- Rehabilitation technique
- Entire asphalt pavement and portion of underlying materials
- Uniformly pulverized and blended
- Results in stabilized base when stabilizing agents are used.

Pavement Recycling Efforts in Alaska

- Primarily using FDR
  - Crush and Compact
    - Crushed Asphalt Base Course
  - Stabilized FDR
    - Cement
    - Foamed Asphalt
    - Emulsified Asphalt
- Very limited use of CCPR
- Availability for Other Processes

318: CR318 include the SNtB item, "Asphalt Material Price Adjustment". Coordinate with other asphalt provisions, the 2017 and 2020 SSHC to avoid conflicts.
ted Sect/Sp: 306/CR306, 401/CR401, 408/CR408, 409/CR409, 703/CR703.1, 702/CR702.2.3

Special Provision

Add the following Section:

SECTION 318
FOAMED ASPHALT STABILIZED BASE COURSE

318-1.01 DESCRIPTION. The work consists of constructing a mixed in place foamed asphalt stabilized base. Create foamed asphalt treated base course by simultaneously injecting and thoroughly mixing metered amounts of asphalt, Portland cement, and water into the pulverized asphalt and base course. Spread, shape, and compact the mixed material according to these specifications and conforming to the dimensions shown on the Plans.

Provide an experienced foamed asphalt technician on site to supervise the foamed asphalt process and to supervise the related process control testing.

At the Preconstruction Meeting, provide information on the equipment proposed for use, the name, and resume of the foamed asphalt technician, and the location of the demonstration site.

MATERIALS

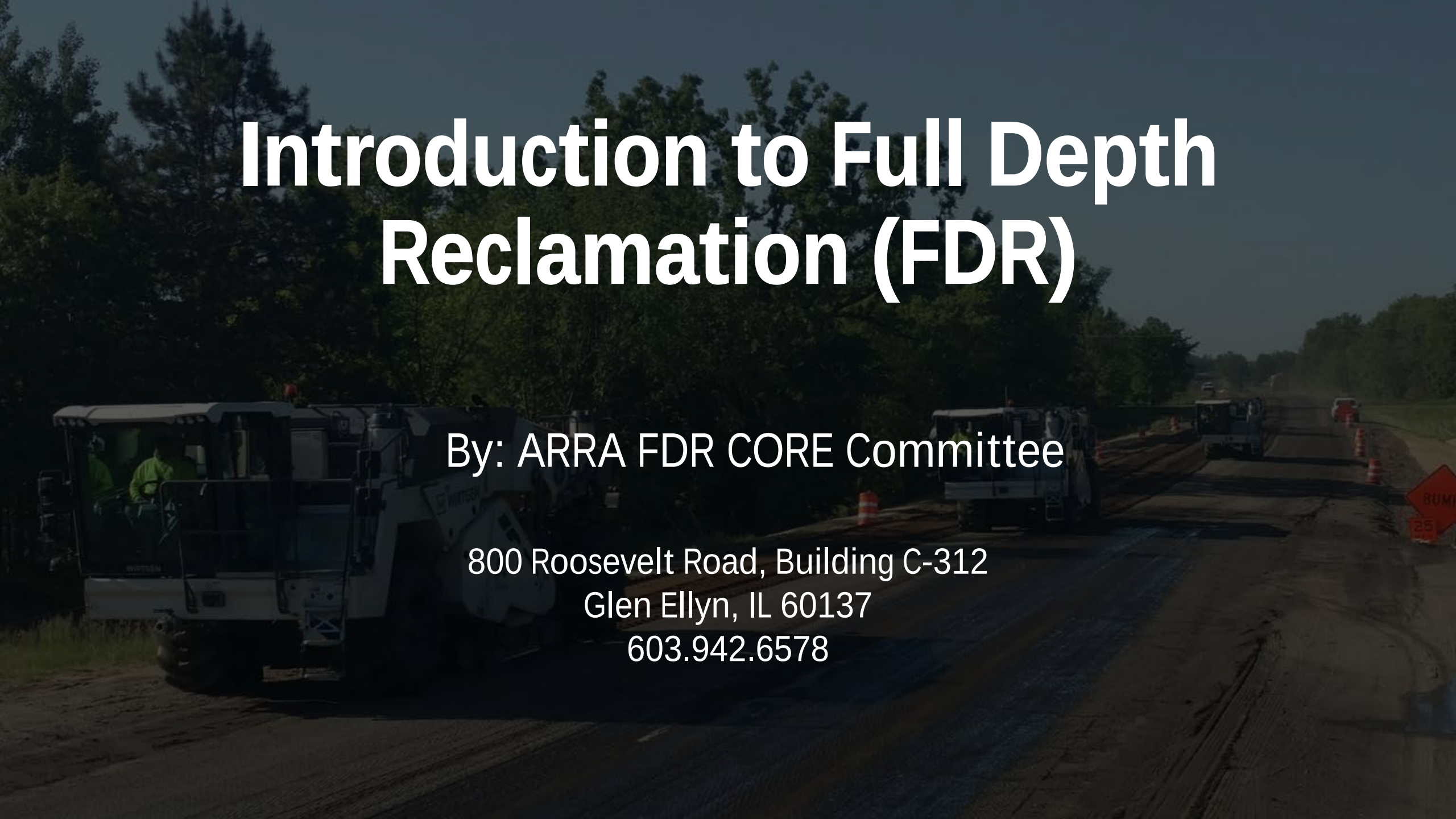
318-2.01 COMPOSITION OF MIXTURE – JOB MIX DESIGN (JMD).

1. Sampling. Before foamed asphalt stabilized base course production, laboratory tests of materials submitted by the Contractor shall be made to determine the quantity of asphalt binder and Portland cement required in the mix. At least 15 days before the production of foamed asphalt stabilized base course, the Contractor shall furnish the following:

   a. 500-pound representative sample of in-place aggregate
   b. 200- pound representative sample of in-place asphalt concrete pavement
   c. 10-gallons of asphalt binder
   d. One sack of Portland cement

2. Job Mix Details. The Engineer will determine the JMD using procedures contained in the Wirtgen Manual Foamed Bitumen Mix Design Procedure, using the Wirtgen WLB 10 to generate foamed asphalt. The JMD will provide the following:

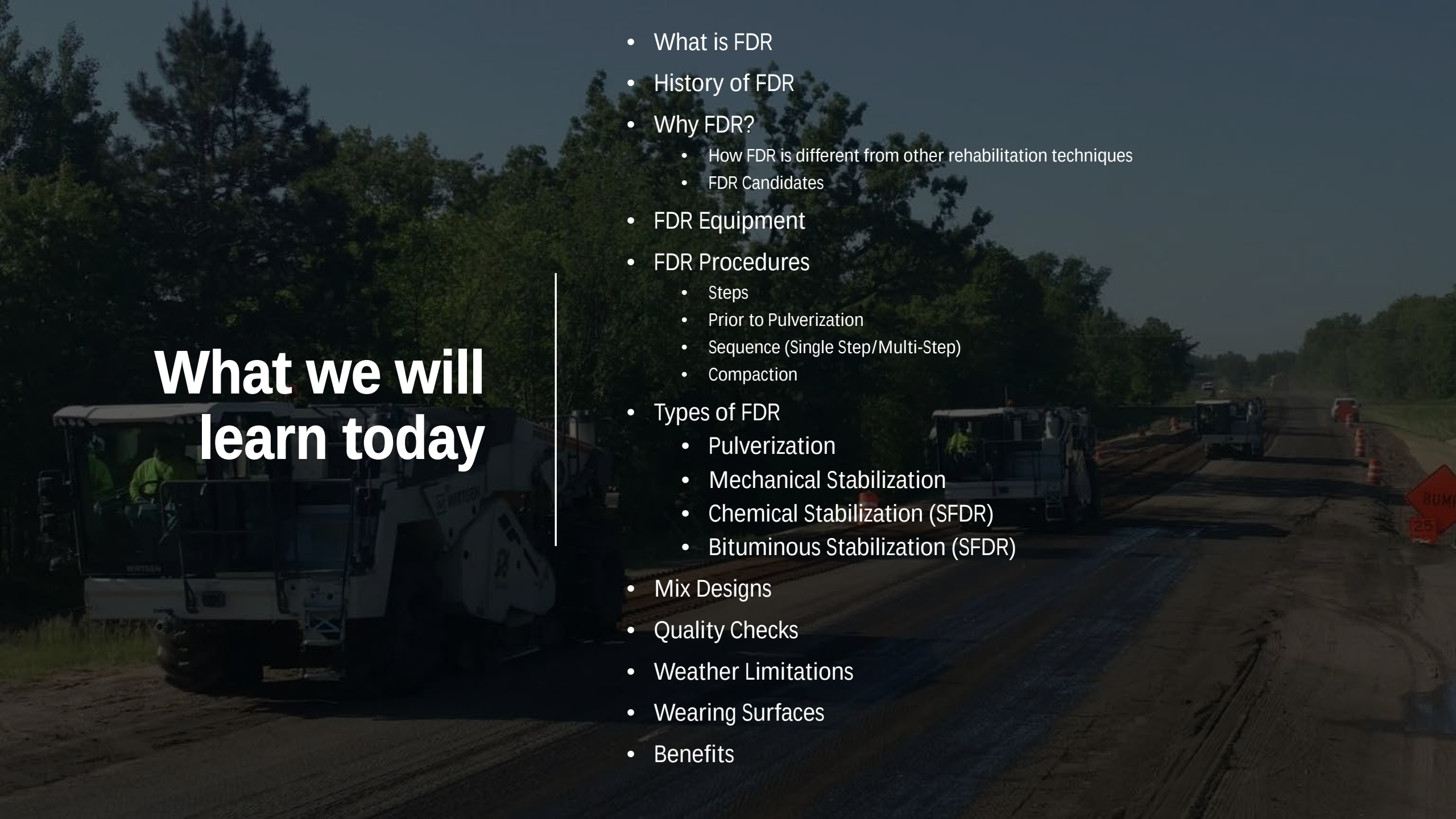
   a. The percent by weight of foamed asphalt binder to be added to the mix.
   b. The optimum percent by weight of water to be added to the asphalt binder for the foaming process.
   c. The minimum Foamed Asphalt Expansion Characteristics required.
   d. The temperature of asphalt binder at the time of injection.
   e. The percent by weight of Portland cement to be added to the mix.
   f. The gradation of the in place aggregate.
   g. The optimum compaction moisture content.
   h. Design dry indirect splitting tensile strength.
   i. The maximum dry density.



Introduction to Full Depth Reclamation (FDR)

By: ARRA FDR CORE Committee

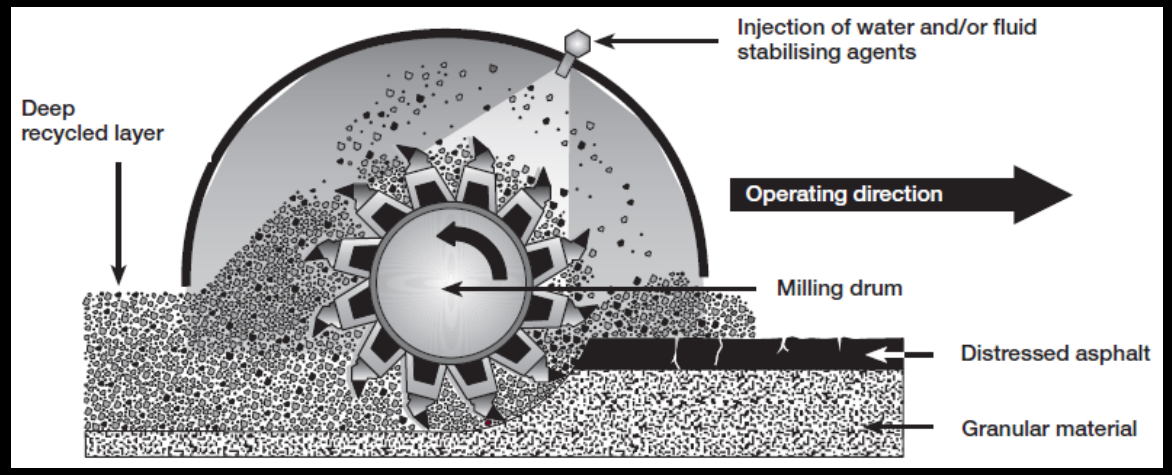
800 Roosevelt Road, Building C-312
Glen Ellyn, IL 60137
603.942.6578



What we will learn today

- What is FDR
- History of FDR
- Why FDR?
  - How FDR is different from other rehabilitation techniques
  - FDR Candidates
- FDR Equipment
- FDR Procedures
  - Steps
  - Prior to Pulverization
  - Sequence (Single Step/Multi-Step)
  - Compaction
- Types of FDR
  - Pulverization
  - Mechanical Stabilization
  - Chemical Stabilization (SFDR)
  - Bituminous Stabilization (SFDR)
- Mix Designs
- Quality Checks
- Weather Limitations
- Wearing Surfaces
- Benefits

What is Full Depth Reclamation (FDR)?



- Pavement rehabilitation technique
- Full flexible pavement section and a pre-determined portion of the underlying materials are uniformly crushed, pulverized and/or blended
- Results in a stabilized base course (SBC).
- Stabilization may be obtained with inclusions of additives
  - More Information to come

History of FDR

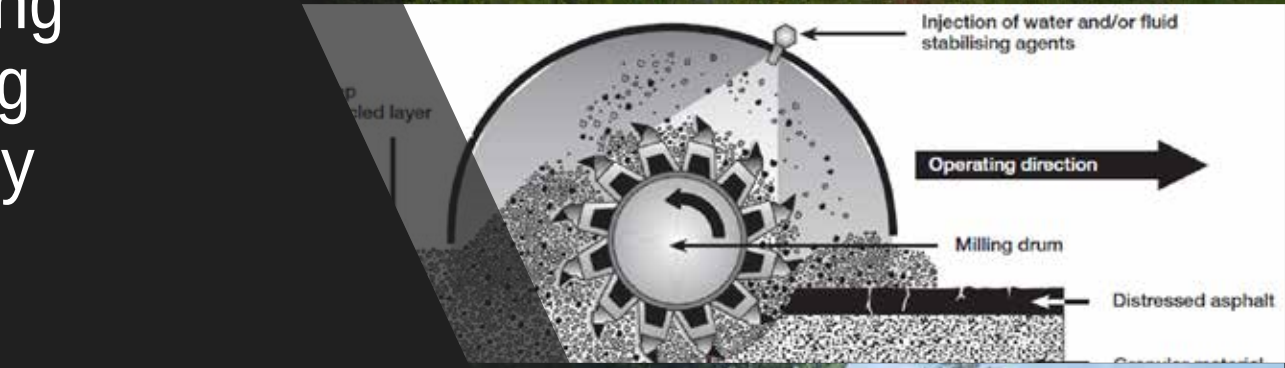
- FDR has historically been undertaken by scarifying the existing asphalt layers with rippers attached to motor graders or crawler tractors.
  - The ripping process produced large blocks of asphalt pavement which were subsequently reduced to smaller, more manageable sizes by travelling hammer mills, grid rollers or similar type equipment.
- The development of rotary mixers in the 1950's enhanced sizing of the previously ripped asphalt pavement and increased productivity.
- The development and widespread use of cold planing machines and the ease with which they removed and sized asphalt pavements led to the production of large, self-propelled, high horse-powered reclaimers.
  - Significantly increased production and facilitated sizing and mixing of the existing asphalt pavement and resulted in FDR as it is known today.

Why FDR?

- FDR rebuilds worn out asphalt pavements by in-place recycling the existing roadway.
  - Eliminates existing materials to be hauled off site and new materials to be hauled onsite,
- Wearing surface applied to complete the pavement rehabilitation
  - Can be surface treatments, hot or cold mix asphalt, or PCC
- The recycled base will be stronger, more uniform, and more moisture resistant than the original base,
  - Resulting in a long-life, low-maintenance pavement.
  - Most important, recycling costs are normally 25 to 50 percent less than removal and replacement of the old pavement.

FDR Comparison

- FDR is distinguished from other rehabilitation methods such as Cold Planing (milling), 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, subbase and/or subgrade layers.



FDR Candidates

- **Flexible Pavement Structures**
  - Interstate Highways
  - Airports
  - Medium and Low Volume Roads
  - City Streets
  - Parking Lots
  - Driveways
  - Etc.

FDR Candidates (Distresses Treated)

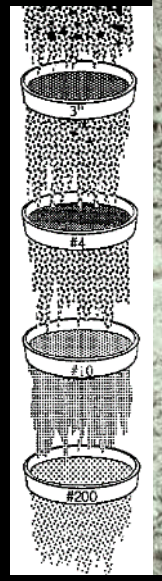
- Alligator Cracking
- Block Cracking
- Longitudinal Cracking
- Transverse Cracking
- Slipping Cracks
- Pot Holes
- Rutting
- Shoving
- Upheaval
- Drainage (FDR alone cannot fix this issue)

FDR Equipment

- Self Propelled Reclaimer
- Motor Grader
- Water Truck
- Compactors
  - Pad Foot
  - Pneumatic
  - Smooth Drum
- Tanker Truck (Bituminous)
- Spreader Truck (Chemical)

FDR Procedures - *Steps*

- Analyze existing materials
- Begin the pulverization process
  - Monitor Depth of cut
  - Monitor Gradation
- Introduce Additive and mix (If needed)
- Initial Compaction (Sheep/Pad foot)
- Shape Material
- Final Compaction
- Apply a wearing course



FDR Procedures - *Prior to Pulverization*

- Identify all active utilities within the recycling area and lower or mark out locations
- Identify all abandoned utilities, rail or streetcar lines, raised roadway markings and other castings within FDR depth and remove prior to FDR
- Remove vegetation and standing water from pavement
- Set up traffic control so traffic can be safety piloted or flagged around the work area
- Correct drainage issues and repair any isolated base failures
- Perform any required grade corrections that cannot be addressed by FDR

FDR Procedures - *Sequencing*

- **Single Pass Reclamation**
  - Used when performing simple pulverization (No additives)
  - Major cross slope/profile grade corrections are not necessary
  - Also can be used when using mechanical stabilization
- **Multiple Pass Reclamation**
  - Pre-Pulverize the existing pavement & underlying layers
  - Pre-shape & compact the pulverized material
  - Apply & mix stabilizing additives (2nd pass)
  - Fine grade & compact the stabilized material
  - Add fog seal or prime coat (As needed)
  - Apply the specified wearing surface

FDR Procedures - *Compaction*

- **Compaction is Critical!**
- **Compaction should always be part of the QA/QC Plan**
- **Typical Compaction Sequence**
  1. Pad-foot compactor (84” drum)
  2. Grade road with motor grader
  3. Rubber Tire (Pneumatic) Roller (25-30 Ton)
  4. Smooth Single or Double drum roller in Vibratory mode
  5. Smooth Single or Double drum in Static mode

Types of FDR

- FDR is broken down into four primary disciplines
  - Pulverization
  - Mechanical Stabilization
  - Chemical Stabilization
  - Bituminous Stabilization

Pulverization

- The most economical FDR Discipline
- Accomplished with a single pass
- In-situ pavement layers & pre-determined amount of underlying materials are pulverized and mixed
- Used when the quality of the pulverized material and designed wearing surface is sufficient to support the anticipated loads
- Moisture (Water) for achieving density is the only material added
- NO STABILIZERS!!!

Mechanical Stabilization

- Utilize pulverized asphalt pavement as an aggregate base
- Add imported aggregate (AASHTO # 3, 57 or 67) or RAP and mix to create a stronger base
- Mechanical stabilization can be performed with a single or multi-pass process

Mechanical Stabilization – Cont.

- **Benefits**
  - Improvement in the gradation of the reclaimed material – increased structural stability
  - The ability to “lean up” in-situ materials containing high asphalt contents, thereby increasing the mixture’s structural stability
  - Cross-slope and/or profile grade corrections can be made without sacrificing section thickness by importing granular materials
  - Widening can also easily be done without sacrificing section thickness
  - Best used on low to medium traffic volume pavements exhibiting the typical surface & minor base defects associated with an aged, oxidized and overloaded pavement
  - Can also be used in combination with other stabilizing additives – Chemical or Bituminous

Chemical Stabilization

- Uses at least one of the following additives
  - Portland Cement (Dry or Slurry)
  - Hydrated Lime or Quicklime (Dry or Slurry)
  - Type C Fly Ash
  - Kiln Dust
    - Cement (CKD)
    - Lime (LKD)
  - Calcium Chloride
  - Other chemical products

Chemical Stabilization – Cont.

- Additive application
  - Slurry additives can either be dispersed ahead of the reclaimer or injected into the reclaimers cutter housing using the onboard material spray bar
  - Dry additives should be applied ahead of the reclaimer in dry powder form on top of the pre-pulverized material
  - These dry additives should be applied using a calibrated spreading unit

Chemical Stabilization – Cont.

- With cementitious or pozzolanic additives strength is gained through the cementing of material particles and aggregates together in the reclaimed layer
- Strength gain is governed by the type of materials being stabilized along with the type and amount of additive used
- Too high of an application rate can result in
  - Strengths that adversely affect the flexibility of the stabilized material
  - Decreased ability to manage repeated loading
  - Shrinkage cracking

Bituminous Stabilization

- Incorporates foamed or emulsified asphalt
- Bituminous stabilizing agents should be incorporated using the multi-pass process to aid in a more consistent injection rate and better mixing
- 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 additional granular materials, cement or lime

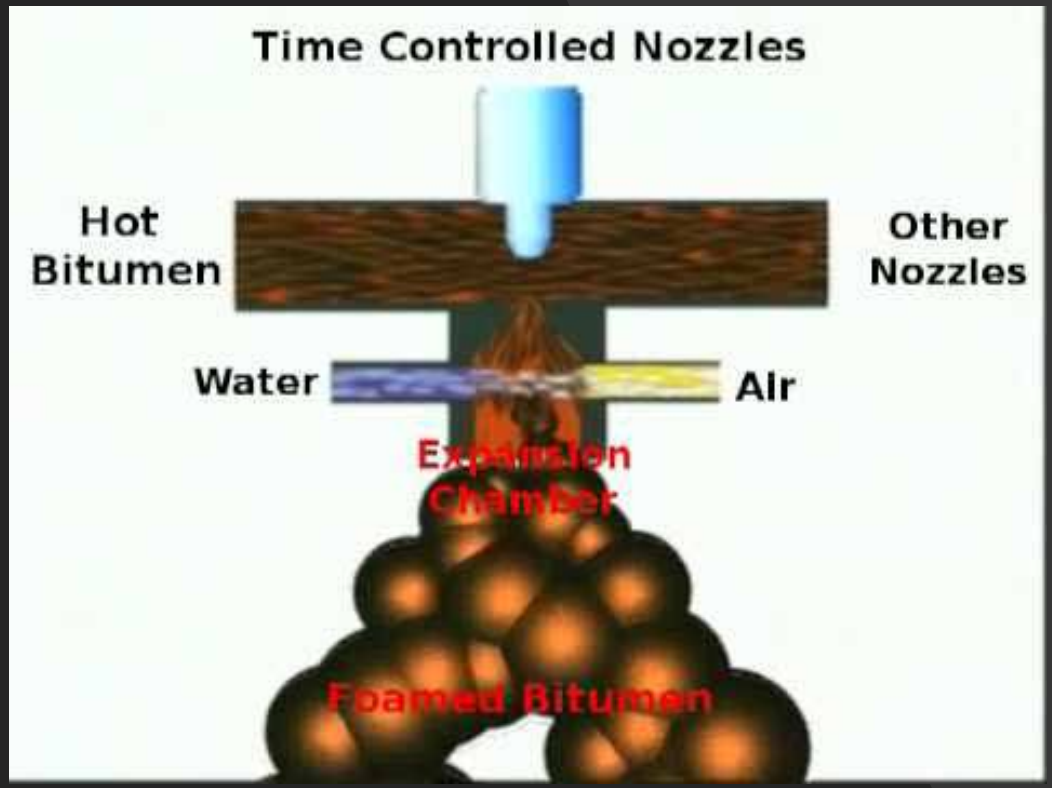
Bituminous Stabilization – Emulsified Asphalt

- Cationic Emulsions are typically used due to their quicker breaking
- Anionic and High Float Emulsions can be used
- Performance of the emulsion and RAP interaction should be verified in the mix design process
- Typical Emulsified Asphalt Composition
  - Minimum 62-65% residual asphalt cement
  - Remainder water, emulsifiers & chemicals

- Breaking
  - The phenomenon when the asphalt and water in the emulsion separate, beginning the curing process. The rate of breaking is controlled primarily by the emulsifying agent.
- Curing
  - The development of the mechanical properties of the asphalt binder. This occurs after the emulsion has broken and the asphalt particles coalesce and bond to the aggregate.

Bituminous Stabilization - Foamed Asphalt

- Uses neat (non polymer modified) asphalt
- How is it made?
  - Elevated temperature asphalt cement (320 - 375 °F) is injected with a small amount of cold water (2% by mass of asphalt)
  - The resulting thermal reaction greatly increases the surface area/volume of the asphalt, thereby decreasing its viscosity and allowing for improved coating of fine aggregates
  - Requires a minimum of 5% fines (passing No. 200 sieve)



FDR Mix Design

- Mix designs are not typically required for pulverization or mechanical stabilization. Testing typically consists of determining the optimum moisture content and maximum dry density using standard or modified Proctor moisture-density tests for use in compaction quality control.
- Mix designs are recommended for all bituminous and cementitious stabilized FDR applications. Adjustments may be required in the field to the stabilizing agent design content to obtain optimum performance.
- See ARRA publication FDR201A and for mix design procedures with emulsified asphalt
  - Available at www.arra.org and www.roadresource.org
- See FDR202 for cementitious FDR mix design procedures.
  - Available at www.arra.org and www.roadresource.org

FDR Quality Checks

- **Typical quality checks**
  - Check depth of pulverization and mixing
  - Check gradation of pulverized material
  - Check stabilizing agent and additive application rates
  - Check/monitor moisture content
  - Check percent compaction
  - Check final grade and alignment

Weather Limitations

- FDR should not be performed when the pavement is frozen or freezing temperatures are anticipated within 7 days of the end of FDR placement
- A minimum ambient temperature of 35 °F (2 °C) is recommended for chemical stabilizing agents
- A minimum ambient temperature of 45 °F (7 °C) is recommended for bituminous stabilizing agents
- FDR should not be performed in moderate to heavy rain

Preparations for Wearing Surface

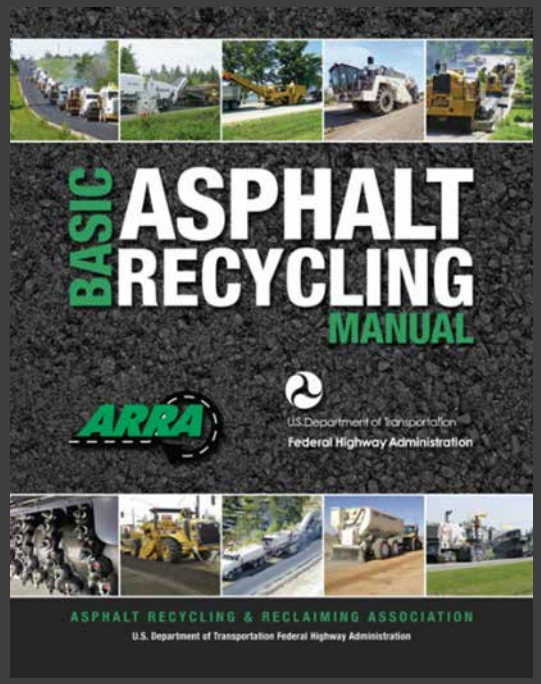
- Allow FDR mixture to properly cure
- Apply tack coat if required
- Apply wearing surface
  - Chip Seal
  - Slurry Seal
  - Micro-Surfacing
  - Cape Seal
  - Cold Mix Overlay
  - Hot Mix Overlay
  - Concrete

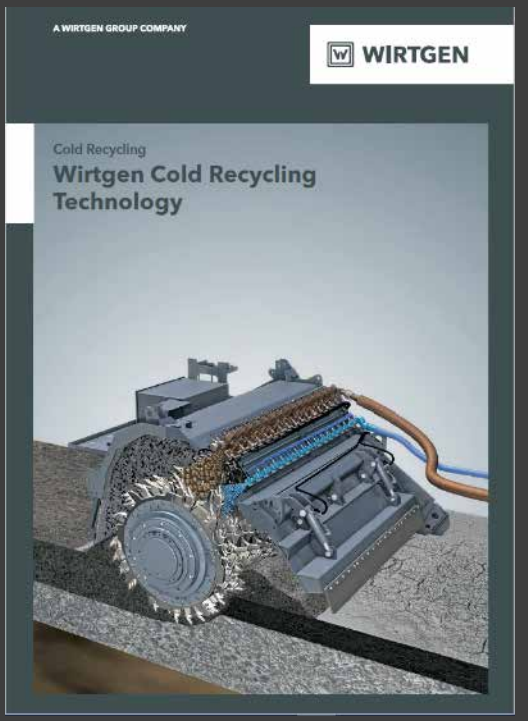
Benefits of FDR

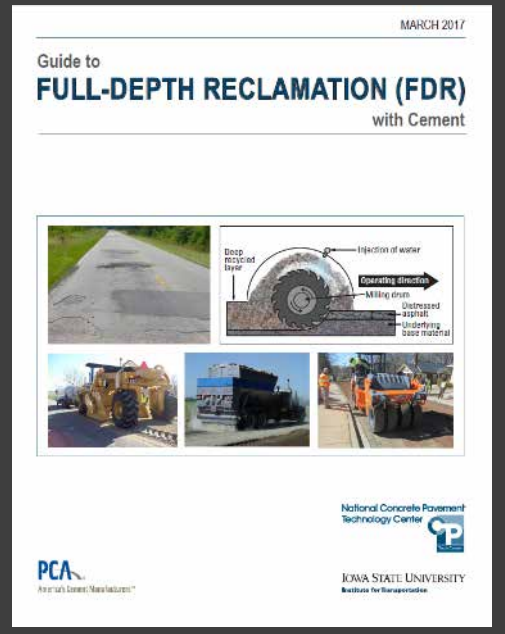
- Eliminates most pavement distress
- Turns a deficient pavement structure into a new homogeneous section with increased structural capacity
- 25 to 50% cost savings compared to other rehabilitation methods
- Same day return to light traffic
- Sustainable: Reuses up to 100% of existing materials conserving non-renewable resources and reducing trucking

For More Information

- www.roadresource.org
- www.arra.org
- Basic Asphalt Recycling Manual
- Wirtgen Cold Recycling Technology
- Full-Depth Reclamation (FDR) with Cement

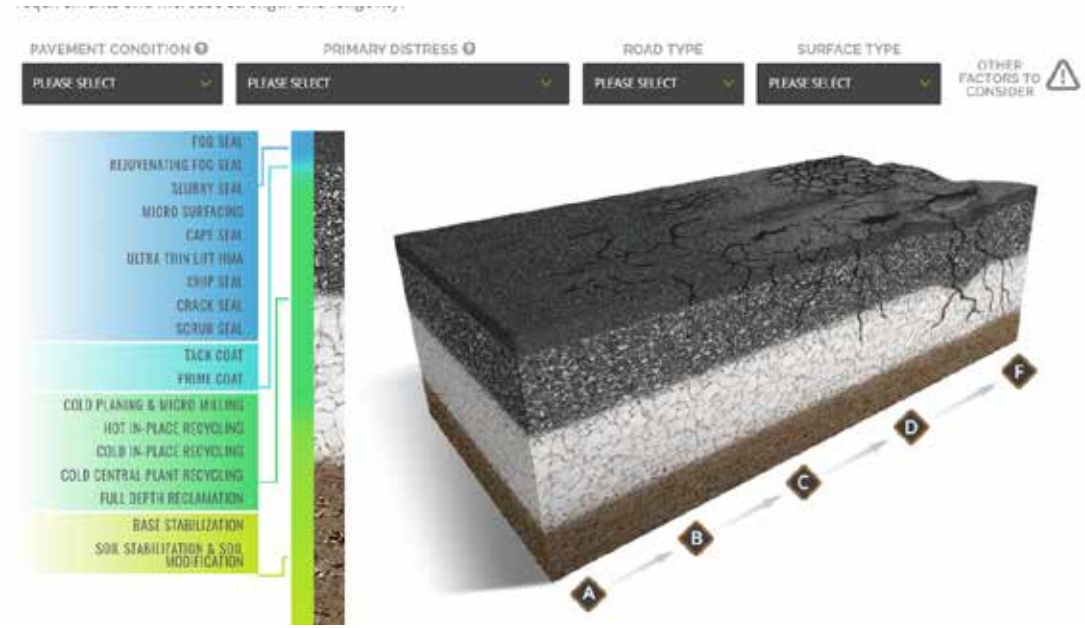






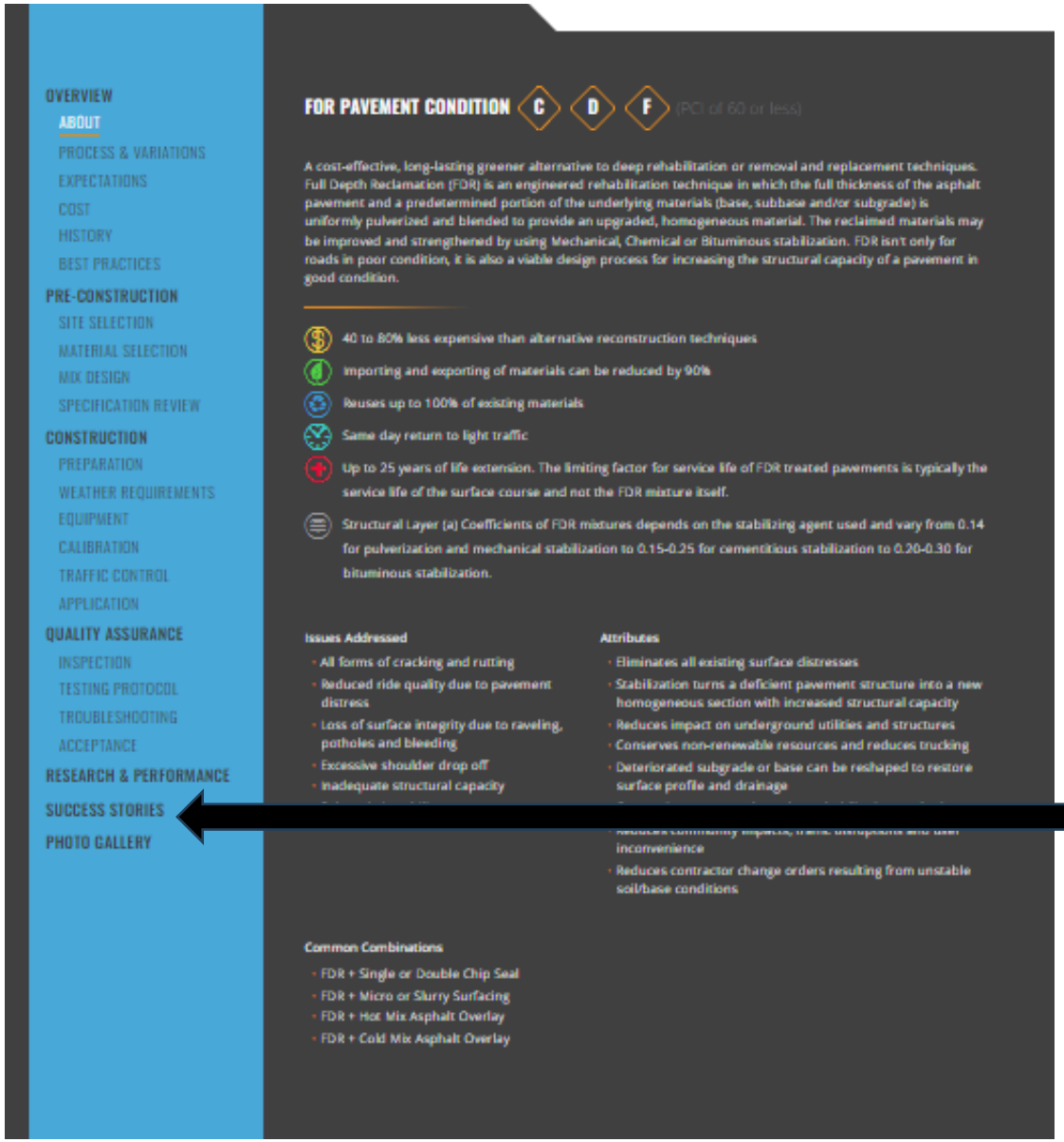
RoadResource.org

- Provided by PPRA
- Treatment Resource Center
- Information on Treatments
- Network Calculators



QPR Link to Article in Asphalt Magazine!!

Treatment Resources



OVERVIEW
ABOUT
PROCESS & VARIATIONS
EXPECTATIONS
COST
HISTORY
BEST PRACTICES
PRE-CONSTRUCTION
SITE SELECTION
MATERIAL SELECTION
MIX DESIGN
SPECIFICATION REVIEW
CONSTRUCTION
PREPARATION
WEATHER REQUIREMENTS
EQUIPMENT
CALIBRATION
TRAFFIC CONTROL
APPLICATION
QUALITY ASSURANCE
INSPECTION
TESTING PROTOCOL
TROUBLESHOOTING
ACCEPTANCE
RESEARCH & PERFORMANCE
SUCCESS STORIES
PHOTO GALLERY

FOR PAVEMENT CONDITION C D F (PCI of 60 or less)

A cost-effective, long-lasting greener alternative to deep rehabilitation or removal and replacement techniques. Full Depth Reclamation (FDR) is an engineered rehabilitation technique in which the full thickness of the asphalt pavement and a predetermined portion of the underlying materials (base, subbase and/or subgrade) is uniformly pulverized and blended to provide an upgraded, homogeneous material. The reclaimed materials may be improved and strengthened by using Mechanical, Chemical or Bituminous stabilization. FDR isn't only for roads in poor condition, it is also a viable design process for increasing the structural capacity of a pavement in good condition.

- 40 to 80% less expensive than alternative reconstruction techniques
- Importing and exporting of materials can be reduced by 90%
- Reuses up to 100% of existing materials
- Same day return to light traffic
- Up to 25 years of life extension. The limiting factor for service life of FDR treated pavements is typically the service life of the surface course and not the FDR mixture itself.
- Structural Layer (a) Coefficients of FDR mixtures depends on the stabilizing agent used and vary from 0.14 for pulverization and mechanical stabilization to 0.15-0.25 for cementitious stabilization to 0.20-0.30 for bituminous stabilization.

Issues Addressed

- All forms of cracking and rutting
- Reduced ride quality due to pavement distress
- Loss of surface integrity due to raveling, potholes and bleeding
- Excessive shoulder drop off
- Inadequate structural capacity

Attributes

- Eliminates all existing surface distresses
- Stabilization turns a deficient pavement structure into a new homogeneous section with increased structural capacity
- Reduces impact on underground utilities and structures
- Conserves non-renewable resources and reduces trucking
- Deteriorated subgrade or base can be reshaped to restore surface profile and drainage
- [illegible] inconvenience
- Reduces contractor change orders resulting from unstable soil/base conditions

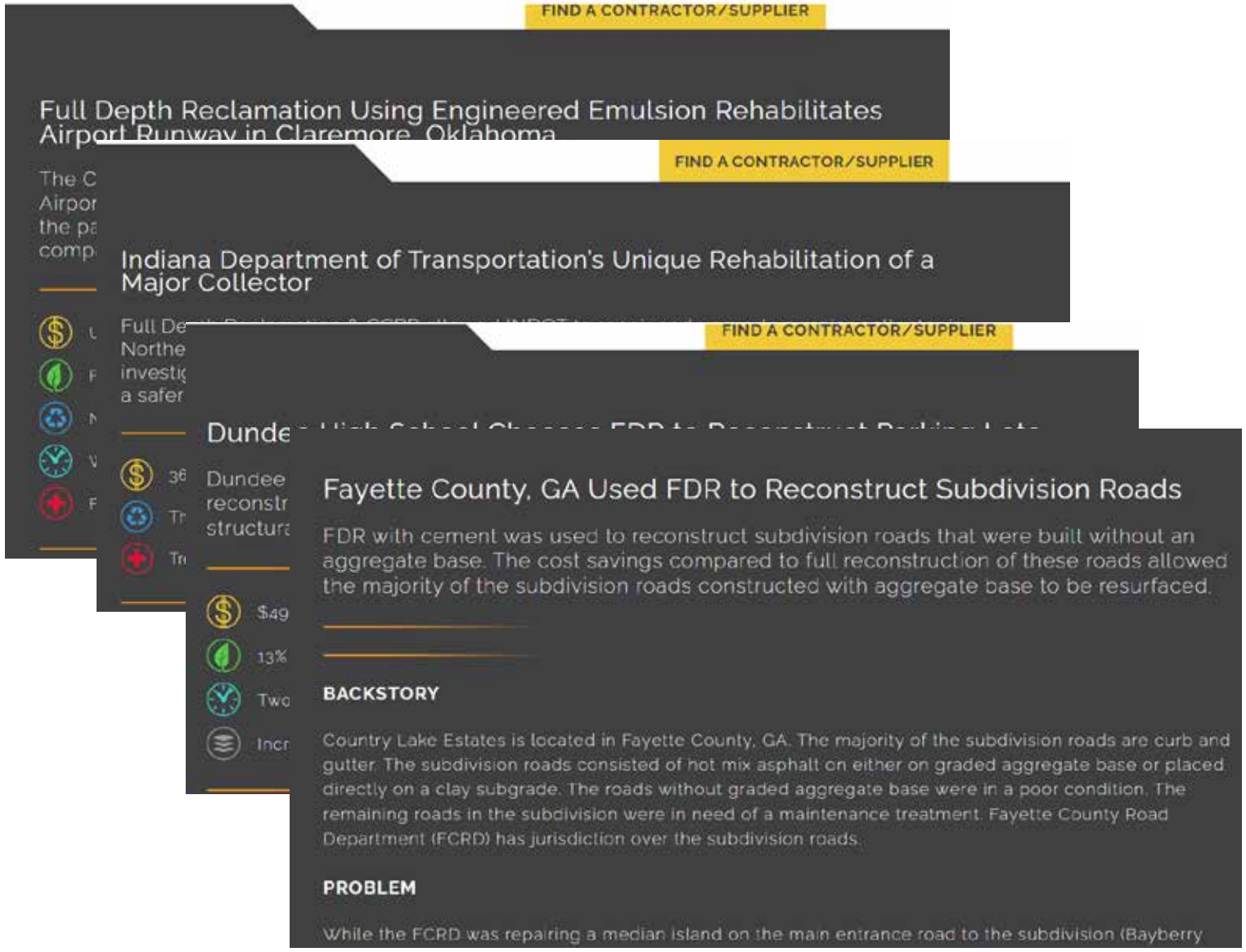
Common Combinations

- FDR + Single or Double Chip Seal
- FDR + Micro or Slurry Surfacing
- FDR + Hot Mix Asphalt Overlay
- FDR + Cold Mix Asphalt Overlay

- Learn from Others
  - Success Stories

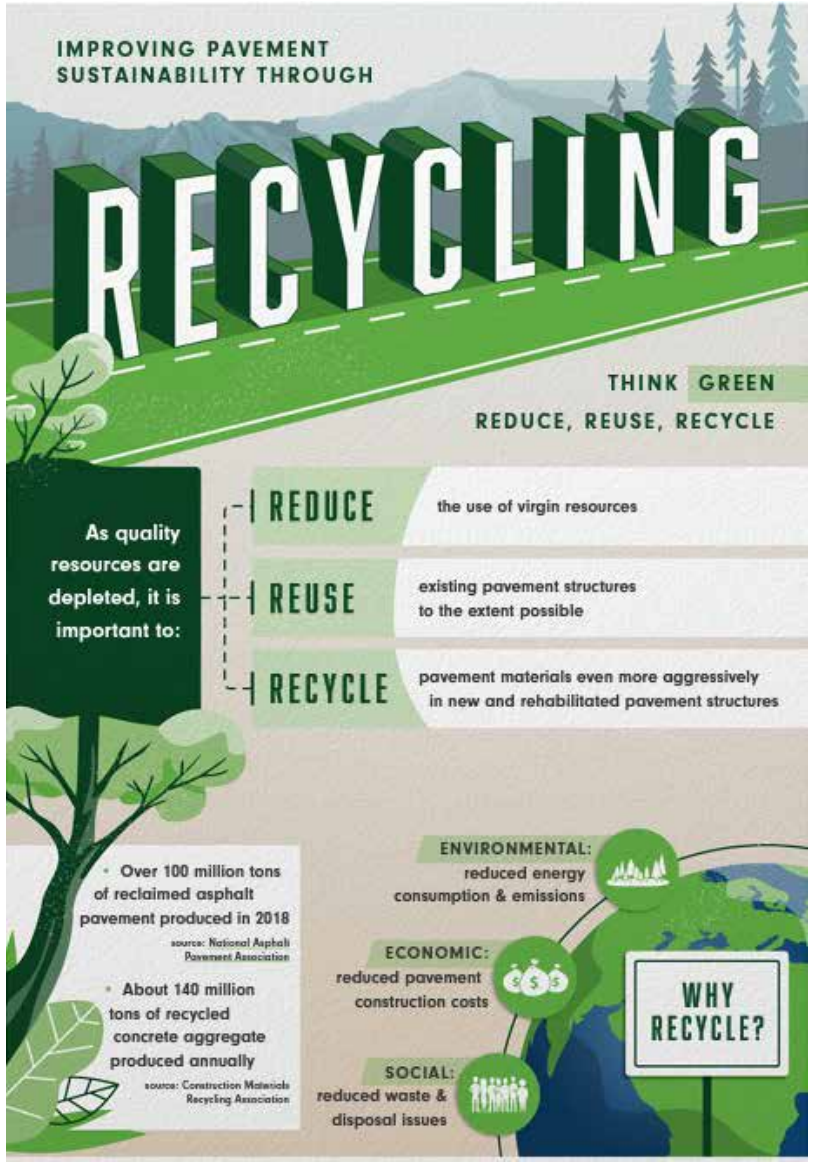
FDR Success Stories

- Airport Runway in Claremore, OK
- Two Lane Major Collector Route in NE Indiana
- School Parking Lot in SE Michigan
- Subdivision Pavements in Georgia



Pavement Recycling: Opportunity for Innovation

- Virginia DOT Case Study
  - FHWA.dot.gov/pavement/sustainability/case_studies
- Challenge:
  - Long-lasting and cost-effective rehabilitation solutions with limited resources and rising construction costs
- Opportunity:
  - Use in-place recycling (CIR and FDR) and CCPR to rehabilitate Interstate highway projects
- Outcomes:
  - Pavements using CIR, FDR and CCPR can be designed for high structural capacities on high volume roadways
  - Reduction of construction time from 2 years to 3-4 months
  - Estimated costs savings realized compared to assumed rehabilitation alternative
  - Reduced energy consumption and GWP reduction realized compared to assumed alternative treatment



Opportunity for Innovation

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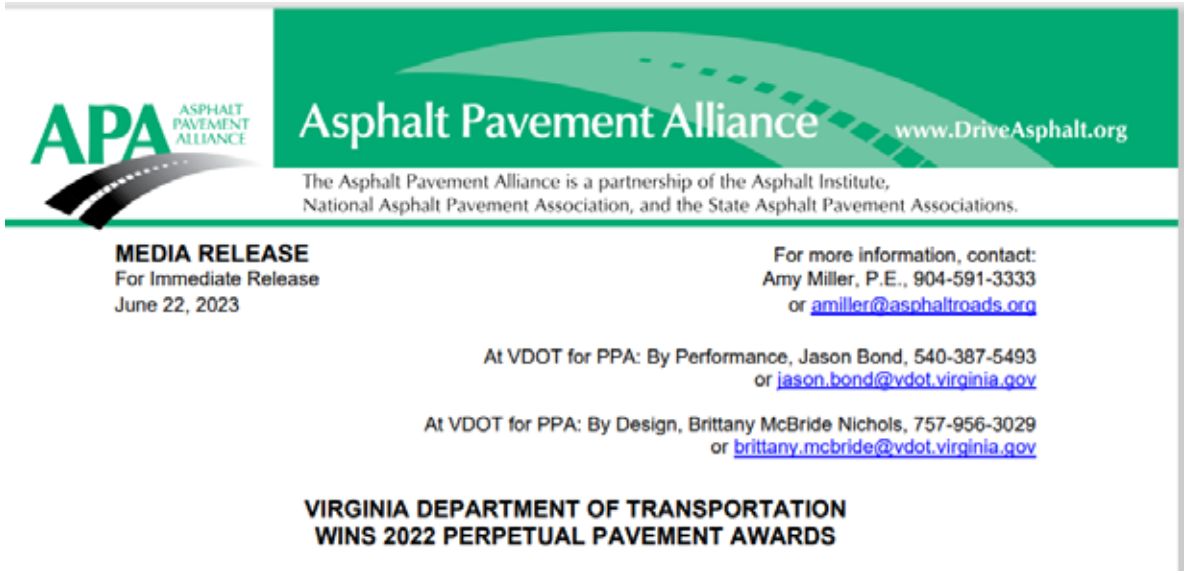
- How are the four pillars being addressed?
  - Performance
  - Environment
  - Economics
  - Social

Pavement Recycling and Performance

- An asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement"
  - *(Asphalt Pavement Alliance, 2002)*
  - *Eareckson Air Station Runway 10-28 (US Air Force – 2002)*
- *APA recognizes new roads that meet perpetual design*
- *I-64 in Virginia first pavement awarded for perpetual design that incorporated recycling processes*



APA ASPHALT PAVEMENT ALLIANCE

Asphalt Pavement Alliance www.DriveAsphalt.org

The Asphalt Pavement Alliance is a partnership of the Asphalt Institute, National Asphalt Pavement Association, and the State Asphalt Pavement Associations.

MEDIA RELEASE
For Immediate Release
June 22, 2023

For more information, contact:
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At VDOT for PPA: By Performance, Jason Bond, 540-387-5493
or jason.bond@vdot.virginia.gov

At VDOT for PPA: By Design, Brittany McBride Nichols, 757-956-3029
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VIRGINIA DEPARTMENT OF TRANSPORTATION WINS 2022 PERPETUAL PAVEMENT AWARDS

"The Virginia Department of Transportation is honored to receive this national Perpetual Pavement Award for the design and delivery of top-quality pavement work as part of the 7-mile reconstruction and widening of the Interstate 64 corridor through James City County, York County and the city of Newport News," stated VDOT Hampton Roads District Engineer Christopher Hall, P.E. "Not only does this highlight our continued commitment to providing a long-lasting, high-quality product for an improved driving experience on the most heavily traveled corridor of the Virginia Peninsula, but also in incorporating innovative and eco-friendly approaches such as utilizing recycled materials, Cold Central Plant Recycling and Full Depth Reclamation, resulting in a significant estimated cost-savings of $10 million for the Commonwealth of Virginia. We are thankful for this recognition and hope this trailblazing approach can serve as a model to be replicated across the rest of the state and beyond."

Ending Remarks

- A good idea is a good idea
  - We succeed when we learn from each other
- Continuous Improvement
  - Always ask “What can we do better”
- Long term performance is a win – win - win
  - Lower overall cost, user delays, and environmental impact

Thank You Members

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Questions

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