Virginia Department of Transportation

Experiences with In-Place Pavement Recycling (FDR)

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In-Place Recycling

- **New Technology for Virginia???**
  - Been used in past
    - Subdivisions
    - Secondaries
  - Limited Use in Recent Years
    - Standard practice has been mill and fill
      - 2 Lifts
    - Potential Use is Greater Now

Virginia In-Place Recycling Industry

- **Primarily FDR**
- **1 contractor using portland cement**
  - completed 3 VDOT jobs (22 lane miles)
- **1 contractor using asphalt (primarily foam)**
  - completed 1 project
  - actively pursuing additional work

VDOT Processes
Richmond District Perspective

- **Selection of future FDR projects – no formal criteria exists**
  - Pavement rating data (NDR, LDR)
  - Pavement history
  - Pavement investigation (FWD, Cores, Subgrade)
  - District decision
- **An option in VDOTs PMS?**
  - Option as a reconstruction alternative
    - Not specifically spelled out
- **How are FDR projects designed – AASHTO 93**
  - Resilient modulus of subgrade (FWD or CBR)
  - Layer coefficient for FDR and CIR = 0.30

VDOT Processes
Richmond District Perspective

- **How is cost-effectiveness demonstrated**
  - Material cost comparison – Reclamation vs Full Depth Replacement
    - Calculated as approx. 45% savings vs. deep mill and repaving
  - Project duration analysis

- **What challenges are faced by decision makers**
  - Acceptance of process (Department, Industry, Public)
  - Performance history

Richmond District Projects

2008

- Single Contract ($2.3 million)
  - Manipulation 8 inches
  - $3.52/sy
- Two Primary Routes
  - Route 13 in Powhatan County
  - Route 6 in Goochland County
- FDR with 5% cement
  - No VDOT Special Provision
  - Project Specific Notes governing work

- Approximate Cost of Cement was $130/ton

2010

- Single Contract ($755,000)
  - Manipulation 12 inches
  - $3.73/sy
- Primary Route
  - Route 60 in Powhatan County
- FDR with 5% cement
  - VDOT Special Provision Included

Route 13

- **8 inch FDR with 2 lift overlay**
  - 1 inch 9.0mm surface (64-22)
  - 1.75 inch 12.5mm surface
- **Pavement Rating of 56**
- **Route Geometry**
  - Two lane primary with 11 foot lanes
    - manipulation total 23 feet
  - Project length 3.71 miles
- **Traffic**
  - 1700 ADT with 11% trucks (8% tractor trailers)
  - Primarily logging trucks
- **Maintenance of Traffic during Construction**
  - Need to return to service upon completion of daily operations
- **Project testing**
  - Depth of manipulation
  - Gradation of manipulation
  - In-place density – average 98% with no 1 test less than 95%

Results

- **Production was approximately 1000 ft/day**
  - Surface Treatment placed prior to opening to traffic
- **Depth (Must be ± 0.5 inch of specified)**
  - No production problems achieving depth of manipulation
    - Isolated locations > 10 inches based on field conditions
- **Gradation (Performed every 1000 feet)**

  2 inch (95 – 100% passing), 1 inch (85 – 95% passing)
  - No issues with achieving gradation
- **In-Place Density (average 98% with no 1 test being below 95%)**
  - Density achieved (No reported failing densities)
    - 250 foot spacing for testing
- **Issues with core hole patching**


Courtesy Slurry Pavers


Courtesy Slurry Pavers

Route 6

- **Mill 2 inches, 8 inch FDR with 2 lift AC overlay**
  - 1.5" 9.5mm surface (64-22)
  - 2 inch 12.5mm surface
- **Pavement Rating of 40**
- **Route Geometry**
  - Two lane primary with 11.5 foot lanes
    - Manipulation total 25 feet
    - Project length was 3.66 miles
- **Traffic**
  - 3800 ADT with 6% trucks (4% Tractor Trailers)
- **Maintenance of traffic during construction**
  - Need to return to service upon completion of daily operations
- **Project testing**
  - Depth of manipulation
  - Gradation of manipulation
  - In-place density – average 98% with no 1 test less than 95%

Results

- **Production was approximately 1100 ft/day**
  - Surface treatment placed prior to opening to traffic
- **Depth (must be ± 0.5 inch of specified)**
  - No production problems achieving depth of manipulation
- **Gradation (performed every 1000 feet)**
    2 inch (95 – 100% passing)
    1 inch (85 – 95% passing)
  - No issues with achieving gradation
- **In-place density (average 98% with no 1 test being below 95%)**
  - No reported failing densities
    - 250 foot spacing for testing


SR-6

Route 60

- **12 inch FDR with 2 lift AC overlay**
  - 1.5 inch 12.5mm surface (64-22)
  - 2 inch 19mm intermediate
- **Pavement Rating of 26**
- **Route Geometry**
  - Two lane Primary w/12 foot lanes
    - Manipulation will total 29 feet
    - Project length was 1.66 miles
- **Traffic**
  - 26,520 ADT w/5% trucks (4% Tractor Trailers)
- **Maintenance of Traffic during Construction**
  - Reduce travel lane to one during construction (permanent)
- **Project testing**
  - Depth of manipulation
  - Unconfined compressive strength
  - In-place density

Results

- **Production was approximately 1750 ft/day**
- **Depth (minimum from approved pavement design)**
  - No production problems achieving depth of manipulation
- **Unconfined compressive strength (minimum 250 psi)**
  - Issues?
  - Specification does not specifically spell out if the criteria is based on average of specimens or individual results.
- **In-place density (minimum 97% of maximum density from design)**
  - No reported failing densities


Courtesy Slurry Pavers


Courtesy Slurry Pavers

Lessons Learned (1)

- **Project Selection**
  - Formal criteria vs. district decision
- **Upfront Homework Important**
  - Pavement Condition – FWD, pavement cores
  - Depth of existing pavement
- **Contractor and Department Experience**
  - Familiarity breeds acceptance/less resistance
- **Need for a Specification**
  - Clearly define requirements
  - Require contractor experience? Does it limit competition?

Lessons Learned (2)

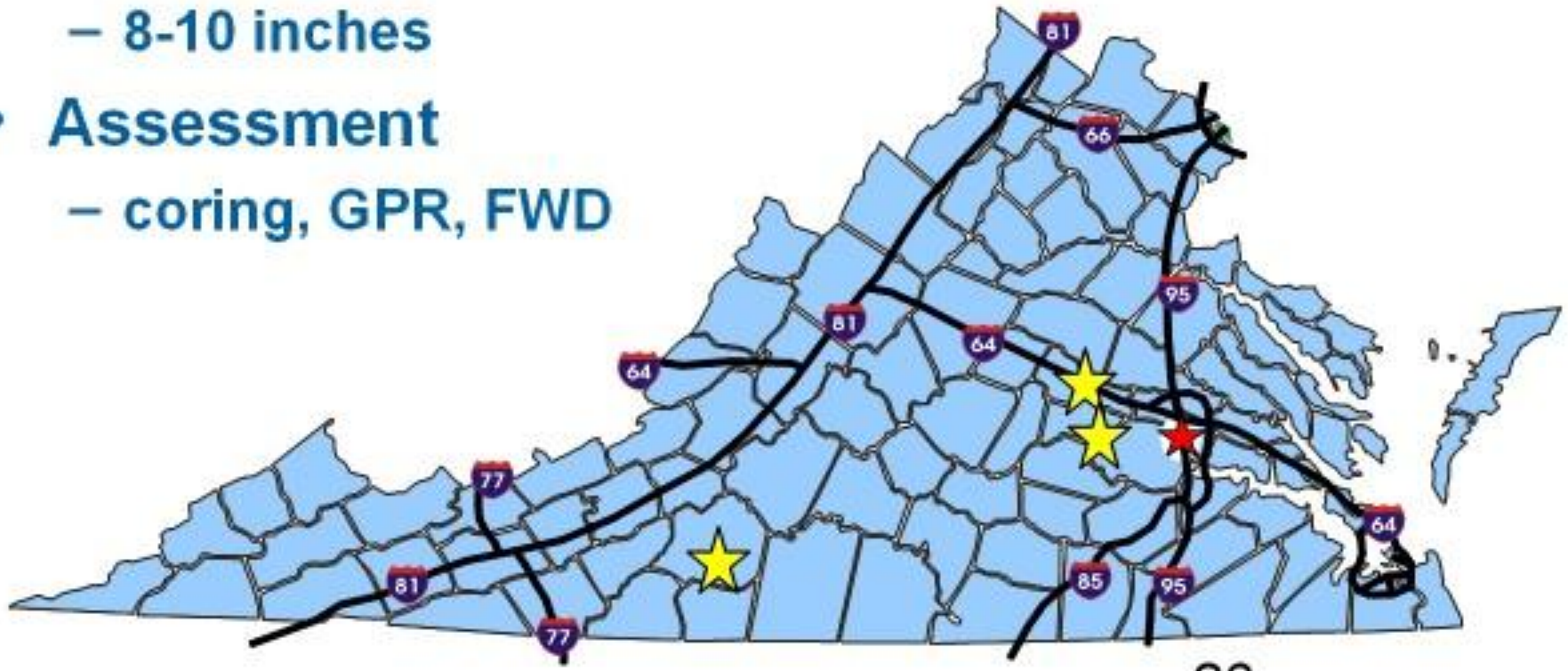
- **Coring samples**
  - Equipment & patch material
  - For lab testing of production, remold loose mix?
- **Proof-rolling**
  - Not part of specification but was performed on each project
- **Performance Monitoring**

VDOT Specification
Full-Depth Pavement Recycling

- **Demonstrated Experience**
  - Contractor demonstrated (successful) experience
    - 3 projects during last 3 years (total of 50,000 sy)
    - Supervisor and equipment operators – 3 projects in last 3 years
  - Submitted to Department for approval
- **Materials**
  - Additional material: aggregate or RAP if needed
  - Stabilizing agent – lime or cement
- **Mix Design - option**
  - Cement/lime content
  - LL, PL, PI of soil
  - Gradation (in-situ material, RAP, other aggregate)
  - Soil classification
  - Compressive strength for soil-cement
  - Soil-lime mixture strength
- **Acceptance testing**
  - Depth & density
  - Unconfined compressive strength
  - Stabilizating agent application rate – Not an "official" criteria but is tracked by project staff

2008 FDR Demo Projects

- State Routes 40, 13, 6
  - 2-lane rural primary
  - 3 binding agents
  - 8-10 inches
- Assessment
  - coring, GPR, FWD

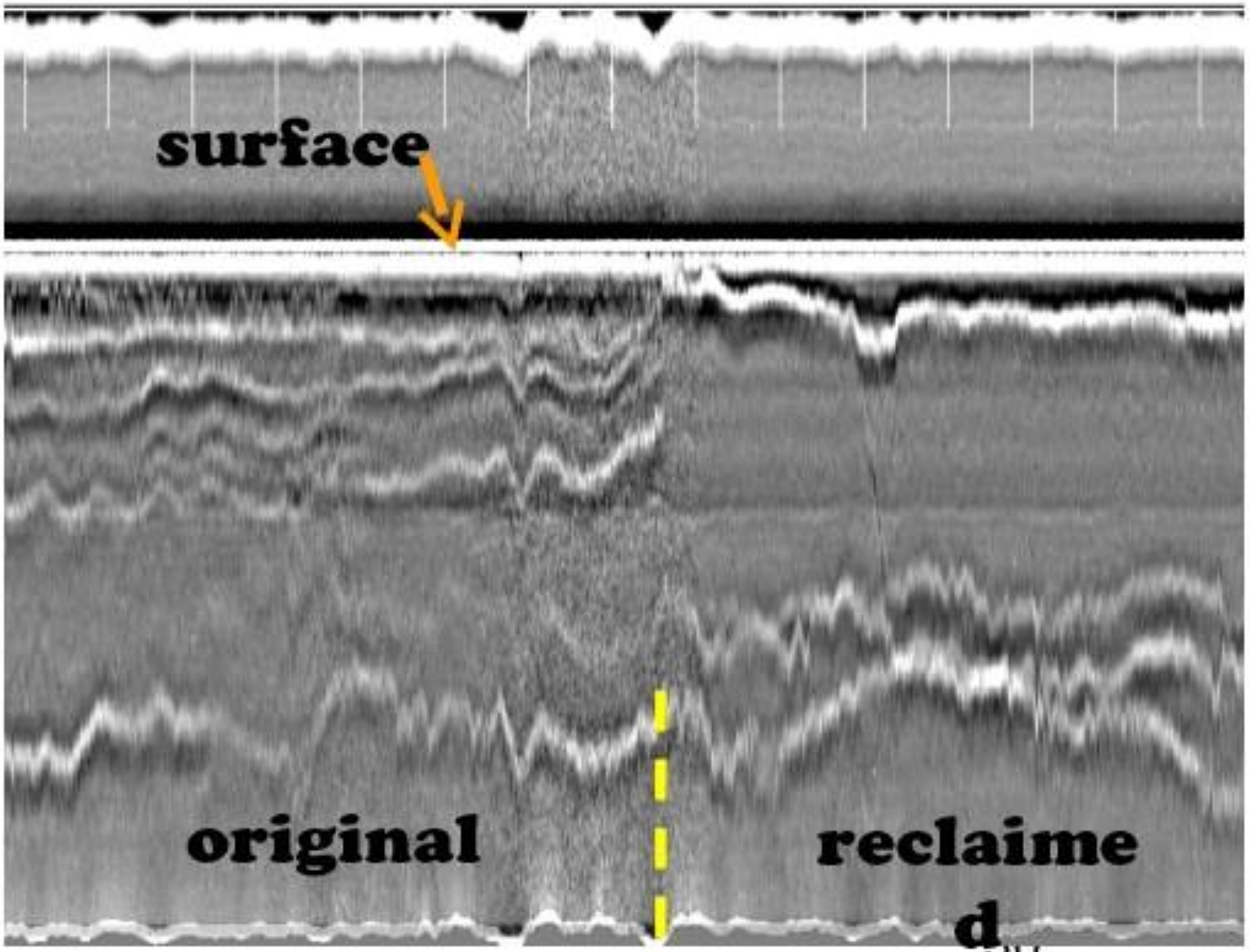


Pulverize existing pavement


Add binding agent (foam)
Water truck
Binder tanker

Add binding agent (emulsion)

Ground Penetrating Radar

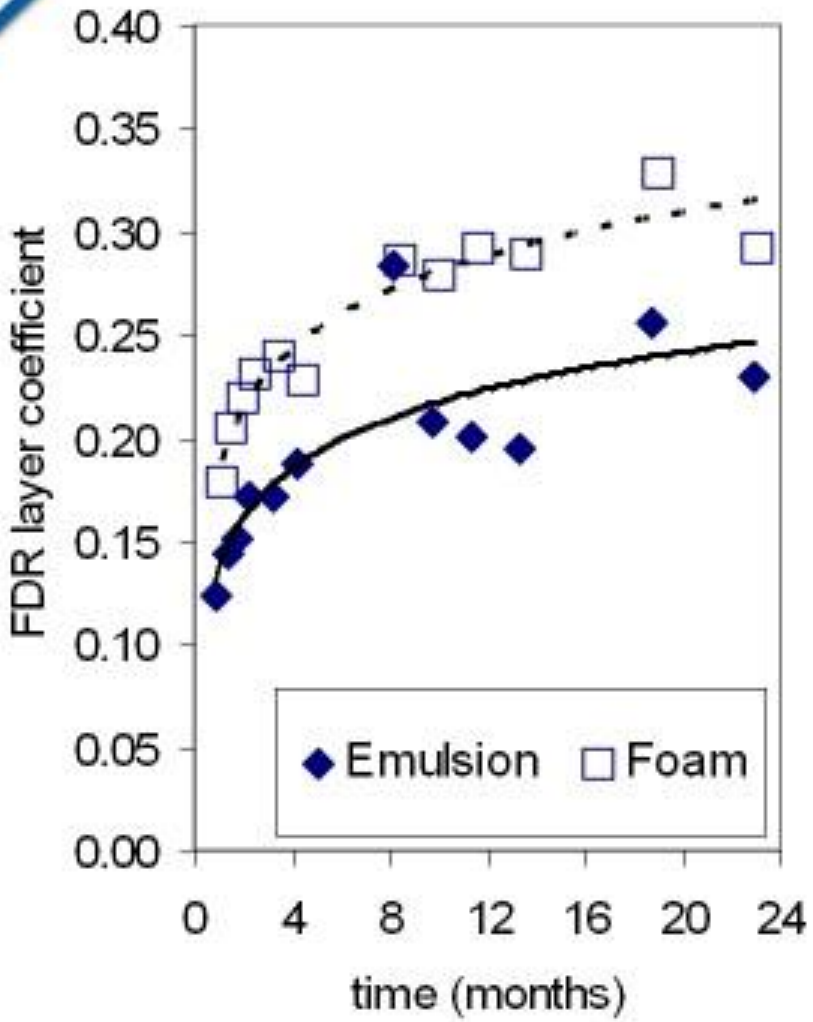


Coring (4 months)

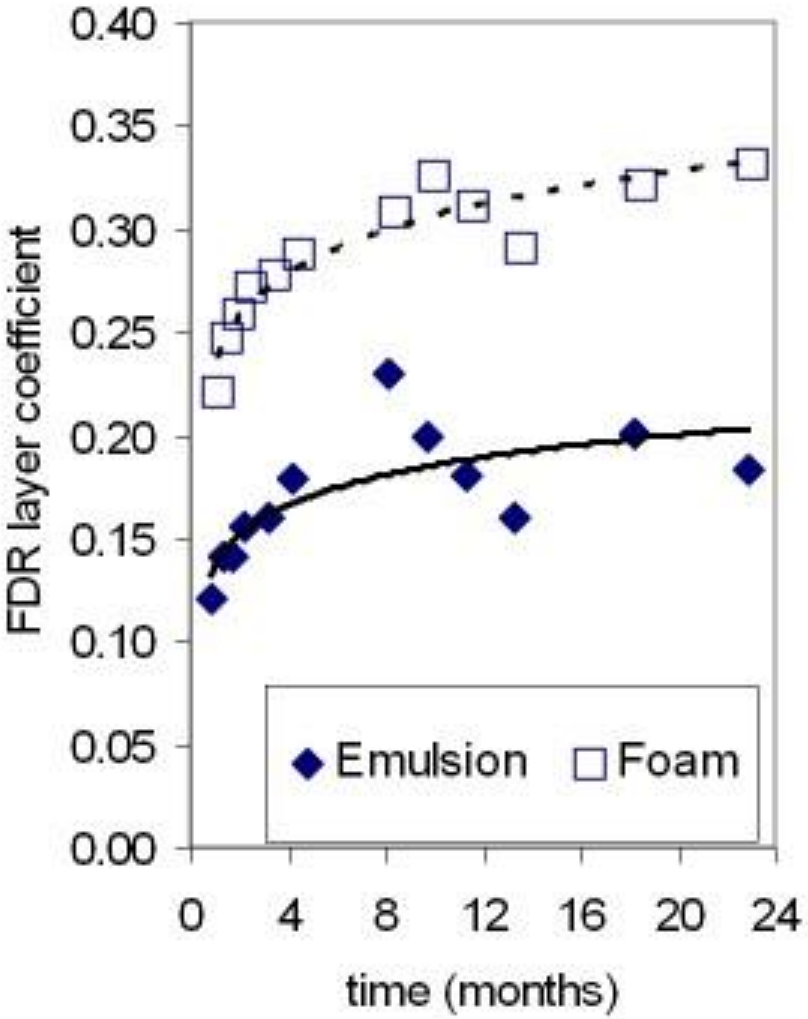
Rt 40, Foamed section

Rt 40, Emulsion section

FWD - Route 40

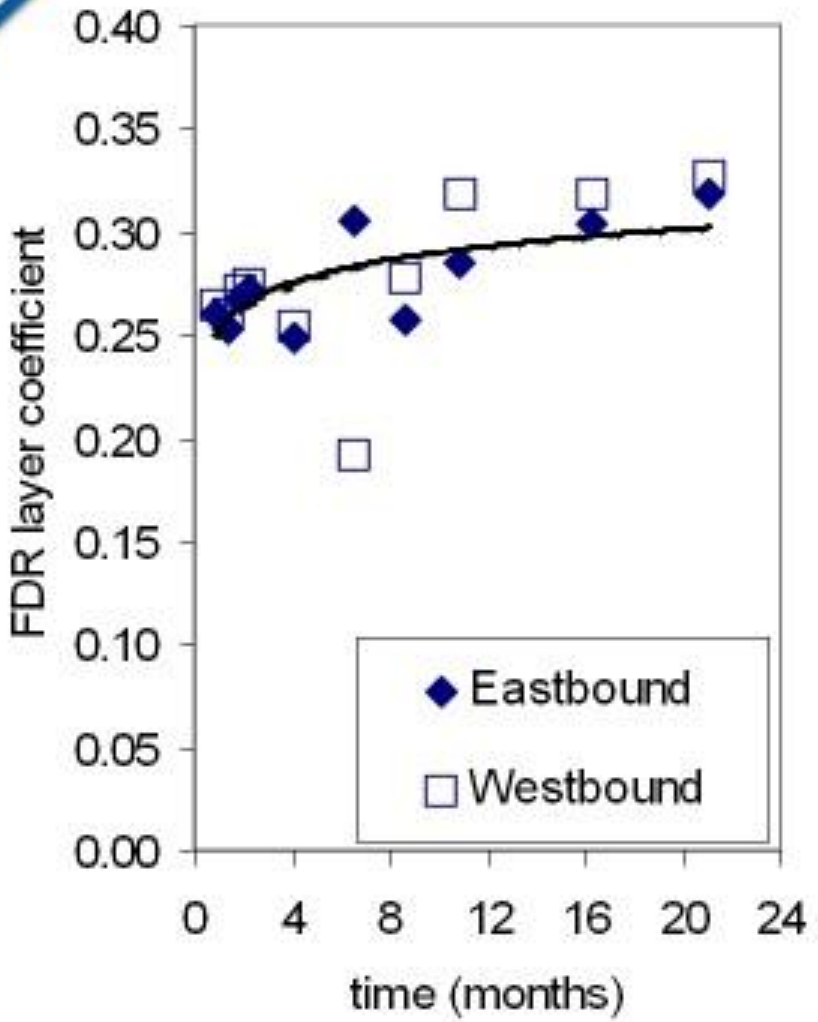


eastbound

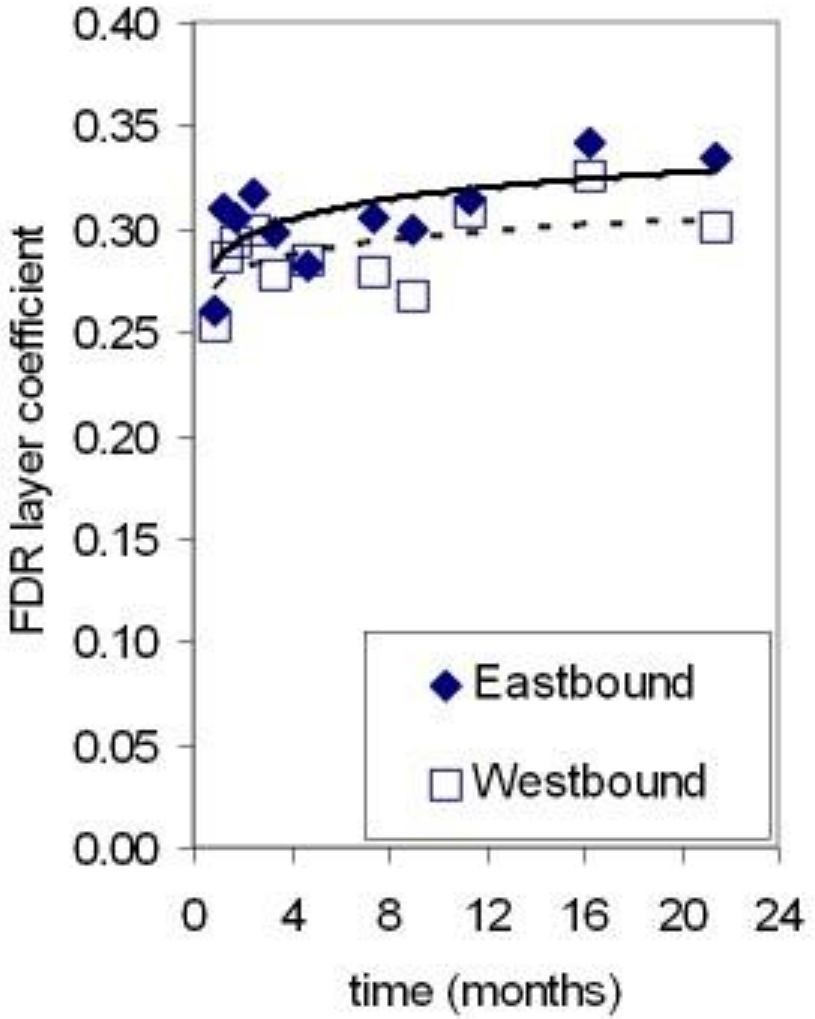


westbound

FWD - Routes 6 & 13



Route 6



Route 13

Virginia In-Place Recycling Outlook

- **Work for 2011**
  - **2 CIR projects out to bid**
  - **Possibly 4 more statewide**
    - long-train vs. dual train vs. single-train?
- **Beyond 2011**
  - **Continue looking for opportunities**
  - **Interstate 81 reconstruction**
    - 7.2 lane miles
    - current traffic approximately 20,000 w/ 31% trucks

Virginia In-Place Recycling Outlook – I-81 Reconstruction

- **Existing condition**
  - 11-12 inches HMA, repaved every 3-5 years
  - Fatigue cracking with fines pumping
- **Design incorporating recycling**
  - 4 inches SMA
  - 8 inches CIR / CCPR
  - 12 inches lime / cement treated subbase
  - Edgedrains
- **Construction estimates**
  - Recycling option = < $10 million
  - Traditional approach = $60-$70 million (3rd lane)

Virginia In-Place Recycling Outlook – I-81 Reconstruction

- Concerns?
  - Rutting
  - Adequate curing before traffic is returned
  - Traffic
  - Funding

- How are we trying to address our concerns?
  - Laboratory testing of similar material
  - Rely on industry / contractor expertise

VDOT In-Place Recycling Research

- **Empirical testing**
  - **develop typical FDR layer coefficient**
    - based on binding agents used on 3 demo projects
  - **rutting tests using asphalt pavement analyzer**

- **Mechanistic testing**
  - **repeated-load permanent deformation (flow number)**
  - **dynamic modulus**
  - **modeling**

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