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**
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
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
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

- **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

- **Materials**
  - Additional material: aggregate or RAP if needed
  - Stabilizing agent – lime or cement

- **Acceptance testing**
  - Depth & density
  - Unconfined compressive strength
  - Stabilizing 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)

Binder tanker

Water truck
Add binding agent (emulsion)
Ground Penetrating Radar

- Surface
- Original
- Reclaimed
Coring (4 months)

Rt 40, Foamed section

Rt 40, Emulsion section
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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