Cost Considerations of In-Place Recycling as a Pavement Rehabilitation Alternative

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Flexible Pavement Rehabilitation

- **State DOT's**
  - **Extend service-life of pavement structures**
  - **Stretch available funding**

- **How?**
  - **Optimize pavement rehabilitation treatments**
    - Based on available funding, other decisions, etc.
  - **Seek use of innovative techniques**

Flexible Pavement Rehabilitation

- **Traditional methods**
  - **Overlay**
  - **Partial- and full-depth mill & replacement**

- **Innovative techniques**
  - **In-place pavement recycling**
    - hot in-place
    - cold in-place
    - full-depth reclamation

FDR and CIR

- **Full-depth reclamation**
  - Bound layers plus a predetermined portion of the unbound materials are mixed and treated to form a stabilized base course
- **Cold in-place recycling**
  - Existing pavement materials (bound layers) are mixed with additives and repaved in-place without the application of heat

Full-Depth Reclamation

- Recommended for pavements with structural deterioration
  - Deep rutting
  - Full-depth cracking
  - Having deep pavement and/or base issues
- Usually performed at a depth of 10-12 inches

Potential Benefits

- **Nevada DOT emphasizes the use of FDR and CIR**
  - **$600 million saved over last 20 years**
    - compared to traditional techniques
- **MTO (Ontario) comparison to mill and overlay**
  - **Emits 50% less green-house gases**
  - **Consumes 62% less aggregates**
  - **Costs 40-50% less**

Bemanian et al. (2006) TRR 1949
Kasmierowski (2008) presentation to AEMA-ARRA-ISSA Annual Meeting

FDR Usage

- **VDOT's use of FDR has been limited**
  - **3 projects in 2008 (approx. 16 lane miles)**
  - **2 projects in 2010**

- **By comparison**
  - **Nevada DOT has completed 900 centerline miles of FDR since 1985**
    - average >40 lane miles per year

Bemanian et al. (2006) TRR 1949

Objective

- **Explore the potential for cost savings if VDOT were to implement an FDR program on its flexible pavement network**
  - **Start with study on primary network and then extend to secondary network**
  - **Could realistic list of candidate sites be developed from typical condition-based criteria?**

Methodology

- **Life-cycle cost analysis**
  - **Present cost methodology**
    - maintenance treatment assumptions
    - statewide average materials and labor cost data
  - **Considered two rehabilitation approaches**
    - partial- and full-depth mill and replacement
    - partial-depth mill and replacement + FDR

- **Applied to pool of potential FDR sites**
  - **Selected based on PMS condition data**

Two Approaches

Year	Partial- and full-depth mill and replacement	Partial-depth mill and replacement + FDR
12	2 inches mill & overlay	2 inches mill & overlay
22	4 inches mill & overlay	2 inches mill & overlay
32	Reconstruct (9.5 inches HMA)	2 inches mill + 8 inches FDR + 4 inches overlay
42	2 inches mill & overlay	--
44	--	2 inches mill & overlay
50	Salvage	Salvage

Cost Assumptions

Item	Units	Cost, $
HMA milling	SY at 2-inch depth	1.50
HMA milling	SY at 4-inch depth	3.00
HMA	Ton (110 lb/SY/inch)	70.00
FDR	SY at 8-inch depth	6.00

LCCA Assumptions

- Based on VDOT's LCCA procedure
  - Analysis period = 50 years
  - Discount rate = 4%
- Existing pavement structure
  - 8 inches of HMA over aggregate
- Layer coefficients
  - HMA = 0.44, FDR = 0.30
- Salvage value
  - Cost of previous treatment multiplied by proportion of life remaining

LCCA Results

- **Partial- and full-depth mill and replacement**
  - **$27.30 / SY**
- **Partial-depth mill and replacement + FDR**
  - **$17.28 / SY**
- **Potential savings of 36%**
  - **Consistent with results found in literature**

Upon Further Review…

- **Preventive maintenance?**
- **LCCA calls for deep mill & replacement at 32 years**
  - **All surface/intermediate layers**
    - Not complete reconstruction
- **Equivalent structural sections**
  - **9.5 inch HMA = 8 inch FDR + 4 inch HMA overlay**
- **When all actions (but year 32) are equal**
  - **FDR savings = 24%**

Extension to VDOT Pavement Network (Primary Routes)

- **Determine initial list of FDR project sites**
  - **2009 automated distress survey**
- **Criteria**
  1. **LDR less than 50**
  2. **Length greater than 1 mile**
  3. **Existing patched area greater than 15%**
     - assumes existing patching to be a temporary repair
- **Result**
  - **251 lane miles at 47 sites**
  - **Average project = 5.3 lane miles**

Extension to VDOT Pavement Network (Primary Routes)

- **251 lane miles = 1.4 million SY**
- **Cost over a 50-year life cycle**
  - **Partial- and full-depth mill and replacement**
    - 1.4 million SY * $27.30 / SY = $38.9 million
  - **Partial-depth mill and replacement + FDR**
    - 1.4 million SY * $17.28 / SY = $24.6 million
- **Potential savings of $14 million**
  - **Primary network only**

Extension to VDOT Pavement Network

- **Primary network**
  - **Potential savings of $14 million**
- **Same criteria applied to secondary network**
  - **230 lane miles at 114 sites**
  - **More difficult to apply same methodology**
    - more variation in pavement structures
  - **Savings could be of similar or greater magnitude**
    - Condition survey covers only 20% of secondary network

Summary

- LCCA compared costs of pavement rehab program using traditional methods versus one that incorporated FDR
  - Present costs were 37% less
- Selection criteria applied to primary network
  - 47 potential sites, $14 million potential savings
  - Similar economic savings over 20% of secondary network

Opportunities

- **Address deep distresses**
  - **Normally covered up with overlays**
- **Ability to remove backlog of highly deteriorated pavement sections**
  - **Achieve longer lasting solution than overlay or mill and overlay**

Next Steps?

- **Decision to include in-place pavement recycling as "standard" option**
- **Identify best candidate locations**
  - **Refinement of project selection criteria**
- **Further research**
  - **Consideration of environmental benefits?**
  - **Consideration of curing**
    - design for initial or long-term conditions

Thank you!

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